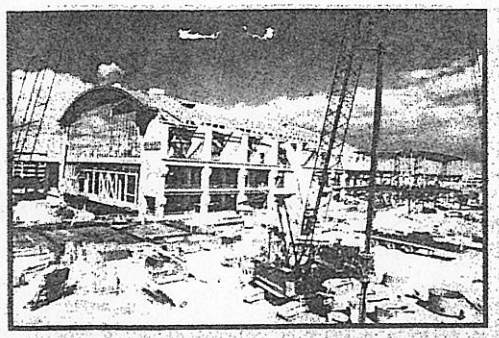
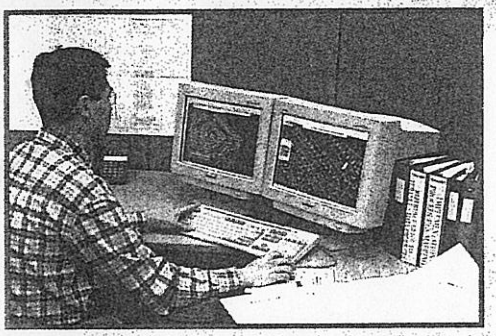
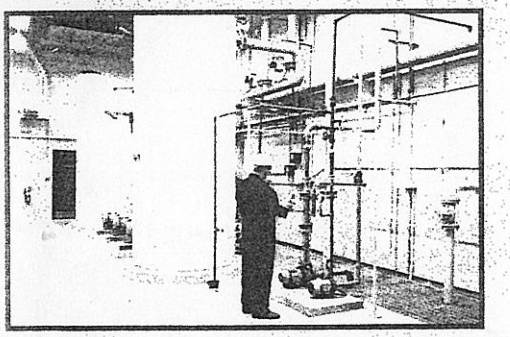
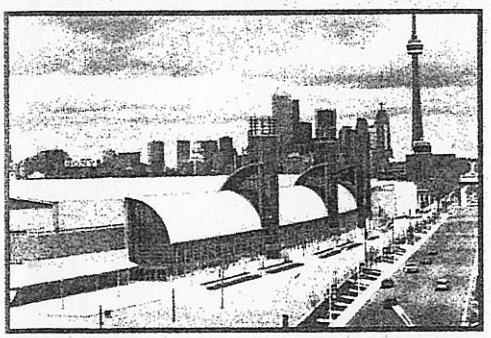
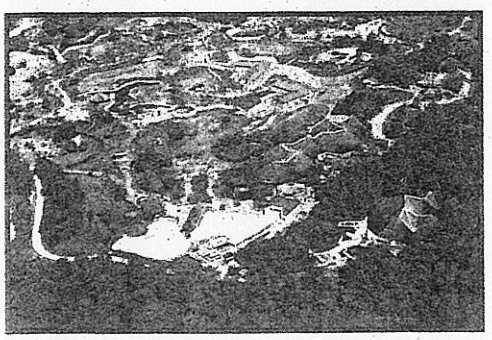










PARTNERS IN PROGRESS 50 YEARS

Hydrogeological Study and Remediation Option Update Report

Oshawa Harbour Marina

Oshawa, Ontario

Prepared For

Oshawa Harbour Commission

Submitted by:

Marshall Macklin Monaghan

PROJECT MANAGERS · ENGINEERS · SURVEYORS · PLANNERS

November 2002

14-02074-01-EM1

Marshall Macklin Monaghan
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

MARSHALL MACKLIN MONAGHAN LIMITED
80 COMMERCE VALLEY DR. EAST
THORNHILL, ONTARIO L3T 7N4
TEL: (905) 882-1100 FAX: (905) 882-0055
EMAIL: mmm@mmm.ca WEB SITE: www.mmm.ca

November 7, 2002
14-02074-01-EM1

Ms. Donna Taylor
Oshawa Harbour Commission
1050 Farewell Street
Oshawa, Ontario
L1H 6N6

Dear Ms. Taylor,

Subject: Hydrogeological and Remediation Option Update of the Oshawa Harbour Marina, Historic Waste Site

---

Please find attached our final report of investigations and assessment of environmental conditions and mitigation alternatives for the historical waste site at the Oshawa Harbour Marina.

Please call us at (905) 882-1100 if you have any questions.

Yours truly,

MARSHALL MACKLIN MONAGHAN LIMITED

Kent Hunter, P.Eng.
Senior Project Engineer
Environmental Management

Murray Gomer, M.Sc.
Senior Hydrogeologist, Project Manager

KDH: J:\1442 Projects by Job Number\2002 Jobs\14-02074-01-EM1 Oshawa Harbour Marina\cover letter.doc
November 7, 2002 8:32 AM

TABLE OF CONTENTS

TABLE OF CONTENTS

APPENDICES

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Hydrogeological Study and Remediation Option Update Report

Oshawa Harbour Marina

Oshawa, Ontario

Prepared For

Oshawa Harbour Commission

Marshall Macklin Monaghan Limited
14-02074-01-EM1
November 2002

J:\1442 Projects by Job Number\2002 Jobs\14-02074-01-EM1 Oshawa Harbour Marina\Report Final 3.doc

Hydrogeological Study and Remediation Option
Update Report

Oshawa Harbour Marina

Oshawa, Ontario

Prepared For

Oshawa Harbour Commission

Marshall Macklin Monaghan Limited
14-02014-01-EM1
November 2002

EXECUTIVE SUMMARY

Marshall Macklin Monaghan was retained to provide environmental consulting services regarding the hydrogeological setting and alternative remediation options for a historic dumpsite at the Oshawa Harbour Marina. Between 1940 and 1957, a portion of the area located between Harbour Road and Oshawa Creek was used for waste disposal. Although formal records do not exist on what was deposited, several studies indicate that wastes disposed of in the dumpsite included construction waste, scrap metal, furnace ash, metal treatment sludge and paint sludge. The area was subsequently developed as basins for the Oshawa Marina, which involved removal of a small wedge of the waste site. In the early 1980s, several environmental reports were completed for the property. The reports indicated that the approximately 26,200 cubic metres of waste fill were placed on the site and the sediments, soils, groundwater and surface water were impacted by inorganic compounds, volatile organic compounds, PAHs and PCBs.

Additional laboratory analysis completed during this investigation basically confirmed the results of the previous investigations; there are concentrations above the provincial and federal guideline criteria. Metals at concentrations which exceed the selected criteria were found in soil and groundwater across the dumpsite. Metal impacts were also detected in surface water from both Basin 3 and Montgomery Creek. VOCs at concentrations which exceed the selected criteria were found in soil and groundwater. Benzene, ethylbenzene and total xylenes were detected in soil and groundwater at the east edge of the site along Montgomery Creek. Chlorinated hydrocarbons (TCE, c-DCE, and VC) were detected in groundwater from various wells at the site. TPHs were found in concentrations above the MOE criteria in soil at three sample locations. No exceedances for PAHs or PCBs were detected, however, these compounds are present at relatively low concentrations that are below the criteria.

We reviewed relevant legislation to evaluate the legal requirements at the site. There is no explicit requirement to remove the waste, however there are federal and provincial requirements to mitigate any adverse or deleterious effects to the environment. Based on the drilling and sampling completed to date, we have not found direct evidence of an adverse effect due to the presence of the dumpsite. However, there is the potential for impacts, which should be addressed. We note that federal guidance documents recommend consideration of onsite management techniques, and evaluation of these methods in comparison to potential impacts caused through removal and relocation of the sediments. Although not stipulated in the regulations, the purchasers of a site may require restoration as a condition of sale of the property.

Remedial mechanisms may include complete dumpsite removal, partial dumpsite removal, isolation of the dumpsite, and/or additional onsite management techniques, including construction of a buffer zone and land use planning.

Excavation and removal of the dumpsite will address most of the environmental concerns regarding the dumpsite, however, this option is considered cost prohibitive. There are engineering controls which can be used to address all the environmental concerns, without the need to completely remove the dumpsite. Although there is no single engineering control which can address all the concerns, a combination of engineering controls would be

an effective approach. A recommended strategy would involve:

- Grading and capping the dumpsite to minimise potential for leachate generation and reduce the potential for contact between users of the site and the waste,
- Installing a groundwater interceptor between the dumpsite and Montgomery Creek to minimise the potential for leachate migration to Montgomery Creek,
- Complete infilling of Basin 3, to create a buffer to minimise migration of leachate to the harbour,
- Installation of storm water protection along the banks of Montgomery Creek to minimise the potential impacts in the event of a storm, and
- Land-use controls, which may consist of restricting access to the site and activities at the site to assist in minimising the exposure to users.

The capital cost to implement these options will likely be between $500,000 and $1.0 million. Some long term operation and maintenance activities would also be required.

1.0 INTRODUCTION

Marshall Macklin Monaghan was retained to provide environmental consulting services regarding the hydrogeological setting and alternative remediation options for a historic dumpsite at the Oshawa Harbour Marina. The scope of work is presented in our letter of June 6, 2002, and supplemental letter of June 20, 2002. The study area is an area bounded by Harbour Road to the north, Montgomery Creek to the east, the west side of Basin 3 to the west, and the north side of the Basin 2 to the south. A site location plan is included as Figure 1 and a site plan is included as Figure 2.

1.1 Site History

An in-depth review of the site history was completed as part of the study conducted by our office in 1984. The site history was not reassessed as part of this workscope, however, the data from the 1984 study is summarised below:

Early aerial photographs indicate that the marina basins did not extend north of Oshawa Creek; the Oshawa harbour extended southerly from Oshawa Creek to Lake Ontario. Between 1940 and 1957, General Motors Corporation is reported to have used the area located between Harbour Road and Oshawa Creek for waste disposal from their local plant. Although records do not exist on what was deposited, the report prepared by Golder Associates (1983) indicates that wastes disposed of in the dumpsite included construction waste, scrap metal, furnace ash, metal treatment sludge and paint sludge.

Between 1957 and 1976, the study area basically remained unused. The dumpsite was subsequently uncovered during the development and excavation of Basin 3 at the Durham Cruise Marina around 1978. Large amounts of strapping were removed from the Basin 3 area.

Between the late 1970s and the mid-1980s, several environmental studies were completed (discussed in Section 2). During this time, few regulations and guidelines existed, and those that did were in development. Acceptable concentrations of many elements and compounds, with respect to specific criteria, were therefore subject to considerable interpretation.

1.2 Purpose

The purpose of this project is the following:

- To evaluate the current condition of the site and the potential level of impacts of the local environment, with respect to current regulations and criteria and to assess whether remediation or restoration is required,
- To assess historical information and compare with current information, to evaluate whether historical information is relevant,
- To update cost estimates for the remediation options, including partial or complete removal (excavation) of the dumpsite and offer an opinion on the relative risks versus the benefits to the environment and public health,

- To review management-in-place remedial options for the site, and to update these options, with respect to current state-of-the-art and current regulations.

1.3 Scope of Work

The work items that were conducted as part of this project were as follows:

- Gathering and review of relevant reports available from the Oshawa Harbour Commission and our in-house files. The available information was compiled and reassessed with respect to the current environmental regulations and standards,
- Inspection of the site to review constraints and to assess any additional changes which may have occurred since the original studies,
- Review of management alternatives for the dumpsite according to current environmental standards and regulations, and assessment of options, using Biochlor Modelling Software and Flowpath Modelling Software,
- Collection of additional subsurface data to provide visual inspection of the soils, up-to-date analytical data, and to assist us in evaluating the changes that may have occurred since the original report and remediation concepts were developed. A description for the subsurface investigation methodology is included as Appendix A.
- Evaluation and cost analysis of remedial options, based on general market rates and our experience at similar sites.

2.0 SUMMARY OF PREVIOUS STUDIES

We reviewed the available reports as they relate to the study area and summarised the relevant data from these reports in Tables 1 to 4. Borehole locations, estimated from the available reports, are shown on Figure 2. The principle findings of these reports are discussed below:

2.1 Associated Geotechnical 1960

Samples were collected as part of a geotechnical investigation in the area. The logs indicated that ash was present in the vicinity of the dumpsite.

2.2 Industrial Waste Site Identification, Gartner Lee Associates, 1980

Gartner Lee reviewed historical information for Environment Canada (EC), during a program by Environment Canada to develop baseline data on dumpsites in Ontario. They identified the study area as a waste disposal site. A total of 6 test pits were advanced to a typical depth of 1.2 metres. Fill was identified in the area and the logs made specific reference to paint odours. Gartner Lee measured the concentration of methane gas in the test pits, and did not detect any explosive gas (The method of testing is not defined and may not be reliable in an open test pit). Surface water samples were collected from the Basin and Montgomery Creek and analysed for general water quality parameters. The data indicated evidence of leachate was present (elevated conductivity). The data from this analytical work is summarised in the data tables (Table 4a).

Gartner Lee recommended subsequent detailed analysis be completed.

2.3 Subsurface Investigation of Abandoned Waste Disposal Facility, Golder Associates, 1983

A total of 4 boreholes (OBH-1 to OBH-4) were advanced at the study area to a typical depth of 6.5 metres. The boreholes indicated that the soils contained sludge, rust, scale, glass fragments and other signs of waste. Chemical analysis was conducted on the soil, which indicated that the concentrations of TOC, heavy metals and PCBs were elevated. The results were discussed in the report prepared by the National Water Research Institute, and the data is shown on the summary tables 2a, 2b, 2c, 3a and 3b.

2.4 Overview of Environmental Concerns in Oshawa Harbour Area, Environment Canada, 1983

This report summarised previous sampling that was conducted by Environment Canada in 1981 and 1982. In these studies, surface water, soil, and groundwater samples were collected and analysed. The testing indicated contamination of sediments and groundwater by heavy metals in the vicinity of the former dumpsite. The study identified several possible sources for the impacts, which included the dumpsite, but also included urban runoff, coal docks (along the west side of the basin), and a tannery, all of which contributed to the impacts in the watershed. The results on shown on summary tables 1a, 1b (sediments) and

2a (soils).

The study recommended further testing in relation to the dumpsite.

2.5 Investigation of Chemical Concentrations of Durham Cruise Marina, National Water Research Institute, 1984

During this study, surface water and sediment were collected and analysed from Basin 2 and 3. The results indicated that metal contamination was present in the sediment. Borehole data that was obtained by other consultants (Golder in 1983) was reviewed and reinterpreted. The data is summarised on Tables 1a, 1b, 2a, 2b, 2c, 3a, 3b and 4b.

As part of the study, tests were performed which lead NWRI to conclude that there was strong bonding between contaminants and the soil/sediments and the hydraulic conductivity was very low. The report concluded that the existing contamination in the harbour and creek may be either a result of leaching of contamination from the dumpsite, or initial mixing which occurred during construction of the marina and basins, which was never remediated.

2.6 Final Report on Subsurface Investigation of Durham Cruise Marina, Marshall Macklin Monaghan, 1984

A total of 11 boreholes were advanced to identify the extent and nature of the waste on site and the extent and volume of the waste was estimated. Approximately 26,200 cubic metres of waste were estimated to be present at the study area. The waste extends up to 4 metres in depth in certain locations of the site.

Two samples of groundwater were analysed to evaluate the concentration of selected volatile organic compounds (VOCs), and PCBs and three soil samples were analysed to evaluated concentrations of metals (Tables 3b and 2a).

One groundwater sample exceeded the current MOE potable criteria (see Section 3) for VOCs. Several soil samples exceeded the criteria for metals. Detectable concentrations of PCBs were present, however, concentrations were lower than the criteria.

Excavation, as a source of remediation was discussed and the costs were estimated, based on 1984 prices. However, a less expensive option, involving management in place to minimise impacts was also put forward as an alternative to excavation. The study recommended management in place as the preferred option, if remediation is to be conducted.

2.7 Environmental Audit West Harbour Properties, V.A. Wood Associates Limited, October 1993

V.A. Woods conducted an environmental audit on a property located to the west of the subject site. Data relevant to the subject site included groundwater flow information and general hydrogeologic data.

2.8 Oshawa Harbour Pollution Prevention Demonstration Site, Environment Canada, 2000

This study investigated the entire Montgomery Creek watershed, identified sources of contamination, and evaluated the impacts. Sediment samples were obtained throughout Montgomery Creek in 1999. The results are summarised on Table 1a and 1b. Exceedances of metals, PCBs and PAHs are present. During this study, barrels were observed adjacent to the study area. The study made a lot of general statements regarding stormwater management in the entire watershed, but also concluded that a plan should be developed to manage the dumpsite. No management recommendations were made, although on-site containment was acknowledged as one option for site management.

3.0 REVIEW OF REGULATORY FRAMEWORK

The harbour and dumpsite likely fall within the jurisdiction of many different regulatory bodies. This section outlines the regulations and guidelines that may be applicable and develops a basis for evaluating the impacts at the site and appropriate remedial technology(s). In addition, any remediation or mitigation that is conducted must be completed in accordance with the applicable regulations and guidelines that are discussed below.

3.1 Federal Requirements

The harbour is considered a federal facility and therefore federal requirements were reviewed.

3.1.1 Canadian Environmental Protection Act (1999)

The cleanup requirements for the site were assessed in comparison to the *Canadian Environmental Protection Act (1987, updated in 1999).* The *CEPA* provides for the regulation of federal works, undertakings, and federal lands and waters, such as the harbour.

From our review of the act, there are no specific requirements for the removal of a dumpsite or landfill. The act, however, does state that *where there occurs or is a likelihood of a release into the environment of a substance specified on the List of Toxic Substances in Schedule 1 (*the owner) *shall, as soon as possible in the circumstances,*

- *take all reasonable measures consistent with the protection of the environment and public safety to prevent the release or, if it cannot be prevented, to remedy any dangerous condition or reduce or mitigate any danger to the environment or to human life or health that results from the release of the substance or may reasonably be expected to result if the substance is released.*

Schedule 1 contains a list of 26 substances which are considered toxic by definition. Lead, vinyl chloride, 1,1,1 trichlorethane and benzene are included on this list. As well, the term toxic applies to any substance which may be present at concentrations to be considered hazardous to the environment.

The CEPA also regulates "pollution" into marine environments. The CEPA defines marine pollution as *any substances or energy that results, or is likely to result in harm to living resources or marine ecosystems; and damage to amenities.*

The CEPA also contains provisions for the creation of guidelines and codes for environmentally sound practices and for setting objectives for desirable levels of environmental quality.

Therefore, the trigger for a cleanup under CEPA would be if there were "toxic substances" migrating into the environment or pollution migrating into a marine environment.

3.1.2 Canadian Environmental Assessment Act (1992)

The *Canadian Environmental Assessment Act* is a statue whose purpose is to set a framework for planning projects in an environmental sensitive way to avoid an adverse effect. We understand that the projects performed for the Harbour Commission do not require approval under CEAA.

3.1.3 Canadian Environmental Quality Guidelines (2001)

These federal guidelines were developed by the Canadian Council of Ministers for the Environment, which is a federal body that establishes nationally consistent environmental standards, strategies and objectives. The CCME does not implement or enforce legislation, instead each jurisdiction decides whether to adopt CCME proposals. The federal standards developed by the CCME under the CEPA are presented in the *Canadian Environmental Quality Guidelines (2001).* This guideline includes a recommended procedure for assessing sites and contains criteria for groundwater, surface water, sediment and soil.

The site was assessed in respect to these guidelines. Historical and recent data were compared to the criteria values listed in these guidelines to assess whether contamination, as defined under the federal regulations was present.

These guidelines recommend use of the *National Classification System for Contaminated Sites* to evaluate whether action is required. This system is discussed below.

3.1.4 National Classification System for Contaminated Sites (1991)

The National Classification System for Contaminated Sites is a system developed by CCME to assist in evaluating whether an impacted site requires action. The system assigns evaluation factors to various risks, based on the waste type, the degree of hazard, the possible exposure pathways, the possible receptors and engineering judgement. Once the numerical value is assigned, a relatively ranking can be developed to apply to the site.

According to the guidelines, action should be undertaken if the site scores more than 70 using the classification system. The method of action is not specified and may include additional study, remediation, or control. These are guidelines, and not necessarily legislation, however, regulatory bodies may use these guidelines to assess whether action is required, under legislation.

3.1.5 Fisheries Act (1985)

Additional site aspects were assessed with respect to *The Fisheries Act* (R.S., c. F-14, s. 1.). The Act covers many aspects related to fish and fish habitat, and includes the deposition of any substance that is deemed "deleterious," in waters frequented by fish as a violation of the Act. Seepage (such as leachate from a dumpsite) is included as deposition. Deleterious substances are any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.

We have contacted the Ontario Ministry of Natural Resources and they have stated that Montgomery Creek and the marina are considered fish habitat, based on fish evaluation work that was completed in the lower reaches of Montgomery Creek.

Therefore, impacts, such as leachate seepage to the Creek may trigger mitigation under the Fisheries Act, if it is causing a deleterious effect.

The Act also regulates the alteration of fish habitat including alteration, disruption or destruction of habitat (where habitat is defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend, directly or indirectly, in order to carry out their life processes.") This must also be considered when selecting an appropriate restoration approach.

3.1.6 Great Lakes Water Quality Agreement (1971)

The *Great Lakes Water Quality Agreement* (1971) is an agreement between Canada and the United States to restore and enhance the water quality of the Great Lakes. The agreement provides for the governments, in co-operation with State and Provincial Governments to identify the nature and extent of sediment pollution in the Great Lakes System and subsequently develop and evaluate methods to remedy such pollution.

Since this is a federal government initiative, the harbour commission should consider implementing a procedure that follows the steps outlined in the agreement, which are:

- identify existing and potential sources of contaminated groundwater;
- map hydrogeological conditions in the vicinity of existing and potential sources of contaminated groundwater;
- develop a standard approach for sampling and analysis of contaminants in groundwater in order to assess and characterise the degree and extent of contamination;
- estimate the loading of contaminants from groundwater to Lake Ontario to support the development of Remedial Action Plans;
- control the sources of contamination of groundwater and the contaminated groundwater itself, when the problem has been identified; and
- report progress to the federal government.

3.1.7 Guidance Document on the Management of Contaminated Sites in Canada, 1997

This federal document outlines the procedures for management of contaminated sites. It outlines a procedure for assessing and managing sites. The procedure outlined in this document was followed during this assessment.

The guidance document states that evaluation of remediation alternatives *should favour permanent solutions involving contaminant destruction, preferably on site and better still, in situ, thus limiting the handling and potential movement of contaminants in the environment and also associated potential future liabilities... Some methods, such as excavation, can be*

disruptive and cause fugitive dust emissions to the surroundings. The document states that measures must be made to ensure that the remediation process does not present a greater risk compared to risk imposed by the contaminated site. Innovative technologies are viewed in this document as one of the key objectives listed in this guideline.

This guideline also recommends "polluter pays" as one of the key federal principles for site remediation.

Exceedance of the criteria included in these guidelines does not necessary trigger the need for restoration. These guidelines form a consistent basis for evaluating the level of contamination at a site, for the purposes of planning and possibly restoration, if needed.

3.2 Provincial Regulations

The provincial legislation which was reviewed included the following:

3.2.1 Environmental Protection Act (1990)

The Environmental Protection Act (RSO 1990, originally RSO 1980) regulates the discharge of pollutants into the natural environment, and protects human health and plant and animal life against injury and damage. The EPA states that contamination is any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that may cause an adverse effect. An "adverse effect" includes any impairment of the quality of the natural environment for any use that can be made of it, and injury or damage to property or to plant or animal life.

If it is assessed that the dumpsite causes or is likely to cause an adverse effect to any of the receptors in the area then a remediation is triggered under the Environmental Protection Act. The method of mitigation is not presented in the act, nor are the criteria by which an adverse effect may be measured. However, provincial guidelines (discussed below) provide direction to assess whether an adverse effect may occur.

Section 46 of the EPA relates to abandoned dumpsites. The section states that *no use shall be made of land or land covered by water which has been used for the disposal of waste within a period of twenty-five years from the year in which such land ceased to be so used unless the approval of the Minister for the proposed use has been given.* Records retained by others indicate that the dumpsite discontinued use around 1957. However, aspects of site development related to the presence of the landfill should be evaluated and should be evaluated and addressed in a manner that will minimise or eliminate any impacts.

Therefore, a trigger for remediation under the Provincial EPA would be if the contamination at the site causes or is likely to cause an adverse effect.

3.2.2 Ontario Water Resources Act (1990, amended 2002)

The discharge of any material into water that may impair water quality or cause injury to any person, animal, bird or other living thing is prohibited by the authority of the *Ontario Water Resources Act*. This Act gives the MOE extensive powers and authority to control sources of water pollution (surface and groundwater).

Therefore, if the basin, creek or groundwater are being impaired by discharge from the landfill, this may trigger a remediation under the Ontario Water Resources Act. The method of remediation is not outlined, nor are the criteria for evaluating whether an impairment is occurring.

3.2.3 Conservation Authorities Act (1990)

Conservation Authorities have been empowered by the Conservation Authorities Act to undertake programs for the restoration of natural resources on a watershed basis. The Conservation Authority that has authority over the Montgomery Creek and Harbour is the Central Lake Ontario Conservation Authority (CLOCA).

Consultation should be conducted with CLOCA before any restoration work in the harbour.

3.2.4 Guideline for Use at Contaminated Sites in Ontario (1997)

The Provincial procedures for assessing and remediating sites is outlined in *Guideline for Use at Contaminated Sites in Ontario* (1997). These guidelines also contain soil and groundwater restoration criteria, to evaluate the quality and assist in evaluating whether contamination is present. The chemical results from the Oshawa Harbour were compared to the provincial standards.

We contacted the MNR to discuss the site and they have confirmed that the adjacent water bodies are considered fish habitat. According to the guidelines, the site is therefore considered sensitive if it may effect a fish habitat identified by the MNR. Therefore, consultation with the local MNR or conservation authority may be required to evaluate whether the generic criteria are appropriate. The consultation may indicate that the chemical criteria obtained from the soil and groundwater from the site should be compared to background criteria to assess the need for restoration. Background criteria could be site specific background criteria, or Table F of the guidelines.

Exceedances of the chemical criteria contained within this guideline do not trigger the need for restoration. However, the guidelines list 3 instances where site restoration is necessary.

1. Restoration is necessary if contamination at the site is causing, or is likely to cause an adverse effect.

2. Restoration is necessary if recent or historic activities have resulted in the presence of contamination, and a change in current land use is being considered.

3. Restoration is required when the MOE determines that it is necessary. Therefore, the MOE has some authoritative power to use judgement to order a cleanup to protect the environment, without direct evidence of the presence of an adverse effect. It has been our experience that the MOE may order a clean up when contamination is migrating offsite onto neighbouring properties or into surface water.

3.2.5 Water Management Policies Guidelines, Provincial Water Quality Objectives (1999)

Surface water policies and criteria are presented in the *Water Management Policies Guidelines, Provincial Water Quality Objectives (1999),* and criteria for surface water. This guideline is typically used to assess whether impacts in violation of the OWRA are occurring to the province's water.

These objectives were used to assess surface water quality in the harbour and in Montgomery Creek.

The purpose of these objectives is to provide guidance in making water quality management decisions, such as effluent requirements as outlined in Certificates of Approval. An exceedance of these guidelines is not considered a trigger for remediation, but may mean that further degradation shall not be permitted. They may assist in evaluating whether an adverse effect is occurring.

3.2.6 Guidelines for the Protection and Management of Aquatic Sediment in Ontario (1993)

Sediment criteria were evaluated in comparison to the *Guidelines for the Protection and Management of Aquatic Sediment in Ontario*, (August 1993). This guideline was developed to protect the aquatic environment by setting limits for metals, nutrients and organic compounds. This document classifies the sediment according to no effects (clean), lowest effects (requires a management plan) and severe effects (which may require the removal or management of the sediment).

These guidelines were used to assess the quality of the sediment that is present in the basins and harbour.

Exceedance of the guidelines is not considered a trigger for remediation. However, the guidelines are used to assist environmental managers (ministry and the consultants) in making decisions on issues regarding site management, including assessment of the need for restoration.

3.2.7 Additional Guidelines For Developing Remediation Options

The following guidelines were also consulted to evaluate options for remediation.

- *MOE document B-7 Incorporation of the Reasonable Use Concept into MOE Groundwater Management Activities.* This guideline was used to conceptually evaluate buffer zones particularly with respect to infilling of the marina basins. In general, however, this guideline is only applicable to new or expanding waste management sites.
- *A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites* (May 1998). This guideline was used as a baseline to evaluate possible concerns with the dumpsite, and as a baseline for developing options, however, retrofitting the site in relation to these guidelines is not required, because the guidelines do not apply to existing sites which are not being expanded.

- *Guideline D-4 (Formerly 07-07) Land Use On Or Near Landfills And Dumps* (April, 1994). This guideline was reviewed to evaluate specific concerns with respect to the dumpsite. Of particular relevance, this guideline recommends a minimum 30-metre buffer.
- *Procedure B-7-1 (formerly referenced by 15-08): Determination of Contaminant Limits and Attenuation Zones.* This guideline was reviewed and recommends the reasonable use concept to assess the effectiveness of attenuation zones.

3.3 Summary of Regulatory Requirements for the Dumpsite

A discussion of how these regulations and guidelines relate to the contaminants which were found at the site is included as Section 7.

The quality of the soil, groundwater and surface water at the site was assessed by comparing it to the criteria listed in the *Canadian Environmental Quality Guidelines.* In particular,

- Surface water was assessed in comparison to the freshwater criteria listed in Chapter 4,
- Sediment was assessed in comparison to the freshwater criteria listed in Chapter 6,
- Soil was assessed in comparison to the residential/parkland criteria listed in Chapter 7, and
- Groundwater quality was assessed in comparison to the water (community) criteria listed in Chapter 2.

We also compared the soil and groundwater chemical results to the criteria listed in *Guideline for Use at Contaminated Sites in Ontario* (1997). Based on these guidelines, the site may be considered a sensitive site, due to the proximity to Montgomery Creek, which is a fish habitat. Therefore, consultation with the local MNR or conservation authority may be required to evaluate whether the generic criteria are appropriate. The consultation may indicate that the chemical criteria obtained from the soil and groundwater from the site should be compared to background criteria to assess the need for restoration. Background criteria could be site specific background criteria, or Table F of the *Guideline for Use at Contaminated Sites in Ontario.*

Surface water quality was assessed in comparison to the Water Management Policies Guidelines, *Provincial Water Quality Objectives* (1999) and the sediment quality was assessed in comparison to the Guidelines for the Protection and Management of Aquatic Sediment in Ontario, (August 1993).

Of the regulations and guidelines listed above, the Ontario Water Resources Act and Environmental Protection Act were legislation when Marshall Macklin Monaghan produced the evaluation report in 1984. There was no published Ontario or Canadian criteria available to assess the site impacts in 1984 and compel a cleanup.

Based on the guidelines, a buffer zone is required along the perimeter of any new or expanding landfill sites. However, these guidelines do not apply to existing dumpsites and therefore it is our interpretation that the site does not have to be retrofitted with a buffer.

4.0 GEOPHYSICAL CONDITIONS

4.1 Topography and Physiography

The subject site and surrounding area are part of the lowland bordering Lake Ontario and referred to as the Iroquois Plain physiographic region. This area is predominantly a mosaic of till plains, drumlins, and areas of silty lacustrine deposits (Chapman and Putnam 1984). The site has flat relief (77 metres above sea level). There is abundant surface debris (i.e., concrete, metal) in certain areas of the site that may be exposed waste.

4.2 Regional Geology and Hydrogeology

The surface geology consists of glacial lake deposits and modern river deposits (Brennard, 1997; Sharpe et al, 1997). The lake sediments were deposited at the end of the latest ice age, when glacial Lake Iroquois covered the area. The surface geology is predominantly massive to laminated silt and clay, 5 to 10 m thick. Overburden is described in borehole logs as predominantly grey silt clay.

Bedrock is grey and black shale of the Whitby Formation deposited during the Ordovician (MOE, 1998). This unit has a limited effective porosity and generally only the top 3 to 5 m are weathered. Bedrock permeability is anticipated to be variable but low (MOE, 1998).

4.3 Local Hydrogeology

Six additional boreholes were advanced in the vicinity of the dumpsite. The logs for these boreholes are included in Appendix B. The soils encountered during this phase of work were consistent with those historically observed. The soils beneath the subject site are comprised of a silty sand and waste fill of variable thickness (up to 4 m) overlying a grey silt and clay. The waste found during the borehole construction was mostly made up of ash and cinders, wood chips, and debris of glass and concrete. Bedrock was not intersected in any of the boreholes.

An interpretation of the subsurface conditions are presented in the cross sections shown on Figure 3. Cross-section A-A' extends southwest to northeast, along the northwest side of Basin 3; cross-section B-B' extends north-south along the Marina Road (Figure 3). Cross-sections show a silty clay layer overlaid by a deposit of refuse and fill. The thickness of the refuse/fill deposit is variable from a few centimetres up to 4 m.

Two testpits were advanced in the raised area located to the west of the basin. The logs for these testpits are included in Appendix B. These testpits indicated the presence of ash and fill, however, appreciable waste was not present. Laboratory analysis is discussed below.

Groundwater levels are shallow, between 0.7 to 2.2 m below ground. Table 5 summarises the water levels reported in previous reports, water levels measured during this investigation, and water levels measured during the Phase I and Phase II Environmental Site Assessment, completed for the marina property (currently unpublished).

Based on the groundwater monitoring data collected during this study, as well as

groundwater monitoring data collected by our office during the Phase I and Phase II Environmental Site Assessment for the marina (currently unpublished) the principle direction of groundwater flow is from the north-west to the south-east (Figure 4). Therefore, the groundwater flow is toward Basin 3 and Montgomery Creek. The water table is relatively flat with elevations ranging between 75.28 to 75.53 m.a.s.l. on the dumpsite.

During development, purging and sampling collection, monitoring wells recovered relatively quickly (full static water level recover in less than 3 hours after pumping), indicating a moderate permeability. This is likely due to the silty sandy nature of the fill and proximity to the lake. However, due to the low hydraulic gradient (0.0025) resulting from a flat groundwater surface, groundwater flow velocities across the site is anticipated to be low (in the range of 4 metres per year).

5.0 SUBSURFACE SITE INVESTIGATION

5.1 Soil and Water Analytical Results

5.1.1 General

According to the *Guideline for Use at Contaminated Sites in Ontario* (MOE 1997) the site is considered a potentially sensitive site due to Montgomery Creek and the marina having been identified as fish habitats by the MNR. The criteria, which we have used to assess the site, are the generic criteria of the guideline (Table A, residential parkland criteria). This criteria was selected because it is considered to represent a high level of protection for the environment. Consultation with the local MNR or conservation authority may be required to evaluate whether the generic criteria will be considered appropriate. The consultation may indicate that the chemical criteria obtained from the soil and groundwater from the site should be compared to background criteria to assess the need for restoration. Background criteria could be site specific background criteria, or Table F of the *Guideline for Use at Contaminated Sites in Ontario*. It is important to note that if the data is compared to Table F criteria as opposed to Table A criteria, the actual extent of contamination does not change significantly at the site.

Because the Oshawa Harbour operates under Federal jurisdiction, results were also compared to the CCME Environmental Quality Guidelines, where criteria were available.

Table 6 presents a summary of sample exceedances of the Provincial and Federal criteria for soil, groundwater and surface water. When different criteria values exist for the same parameter, the most stringent value was used. For surface water, the Provincial Water Quality Objectives (PWQO) and the CCME criteria were used as criteria for comparison.

5.1.2 Soil Chemistry

Samples were selected for laboratory analysis, to supplement the existing data, and to allow an updated evaluation of the level of impact at the site. Table 6 provides a summary of the exceedances, and Tables 7a to 7e provide the analytical detail for the soil samples submitted during the subsurface investigation, including sample ID and depth, measured concentrations, and criteria values of the relevant guidelines and standards. Tables 2a to 2c also include the available historical data for soil. Appendix C contains the laboratory Certificates of Analysis. The following paragraphs discuss soil chemistry for the current work program.

Landfill Gas

Gas concentrations measured in the monitoring wells are shown on the Borehole logs in Appendix B. Gas concentrations measured during this phase of work indicated that the vapour concentration is a maximum of 142 ppm (measured with a photoionization detector (PID)). This is not unusual given the presence of volatile organic hydrocarbons on the site. Historical gas measurements taken from the soils are low, however, they may not be reliable, because they may have been obtained from open testpits.

Metals

Twelve metals were detected at concentrations exceeding the MOE or CCME criteria (Table 6). Elevated concentrations of antimony, cadmium, chromium, copper, lead, and zinc were found in all the soil samples tested, except for MMM02-06-SS1 (the background well). Arsenic, cadmium, molybdenum, and nickel exceedances were detected in five of the soil samples; cobalt exceeded the MOE criteria in two sample locations; and barium was detected in the two samples taken from MMM02-04.

Similarly, eight metals exceeded the CCME criteria for soil. The only sample that did not exceed any of the criteria was SS1 from sampling location MMM02-06 (the background well).

Previous studies had also identified metal impacts on soil across the Site (Table 2a).

Volatile Organic Compounds

VOCs were detected in concentrations above MOE criteria at MMM02-2, as follows:

- Ethylbenzene was detected at a concentration of 11.1 µg/g in borehole MMM02-2 between 0.76 to 1.52 m below ground; the MOE Guideline criterion for Ethylbenzene is 0.28 µg/g for medium to fine soils.
- Total xylenes was detected at a concentration of 51.8 µg/g in borehole MMM02-2 between 0.76 to 1.52 m below ground (MOE criterion is 25 µg/g).

Concentrations slightly below the criterion for 1,3-dichlorobenzene and toluene were measured at sample locations MMM02-2 (21.4 and 1.5 µg/g respectively) between 0.76 to 1.52 m below ground (Table 7b). None of the CCME criteria for VOCs were exceeded.

Total Petroleum Hydrocarbons (TPHs)

Concentration above the MOE criterion of 100 µg/g for petroleum hydrocarbon (gas/diesel) were detected in three samples MMM02-01 SS1 (230 µg/g), MMM02-04 SS4 (130 µg/g), and MMM02-05 SS1 (260 µg/g). A concentration slightly below the criterion for heavy oil was found at sample MMM02-01 SS2 (Table 7c).

Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs)

No exceedances were detected in soil during the subsurface investigation for PAHs, and PCBs (Tables 7d and 7e, respectively). Previous studies had identified concentrations for benzo(a)pyrene above the CCME criterion at two locations.

5.2 Groundwater Quality

The groundwater analytical results were compared to the MOE potable groundwater criteria from Table A of the MOE Guideline. The criteria value for medium and fine soil textures were used, where applicable. For comparison we used the CCME water criteria for community groundwater uses. Table 6 presents a summary of the exceedances detected in

the groundwater. Tables 8a to 8c provide the analytical detail for the groundwater samples submitted, including sample location, parameters analysed, and exceedances identified. Appendix C contains the Certificates of Analysis.

5.2.1 Metals

Five metals were detected at concentrations exceeding the MOE or CCME criteria (Table 6). Manganese exceeds the CCME recommended criterion at all sample locations and iron at location MMM02-1 to MMM02-4. Antimony exceeds the MOE recommended concentration at MMM02-2, MMM02-3 and MMM02-5, and nickel and zinc were detected in concentrations slightly above the criteria at MMM02-2.

Previous studies had identified metal impacts in groundwater from copper at two sample locations.

5.2.2 Volatile Organic Compounds

VOCs were detected in concentrations above the MOE criteria in groundwater. VOC exceedances were measured at all monitoring wells except for MMM02-6, as follows:

- Benzene was detected at concentrations 5.8 and 37.1 µg/L at MMM02-1 and MMM02-3, respectively. The MOE criteria for benzene is 5 µg/L;
- Ethylbenzene was detected in concentrations above the MOE criterion (2.4 µg/L) at MMM02-2 (54.7 µg/L) and MMM02-3 (24.5 µg/L);
- Total xylenes exceeded the MOE criteria (300 µg/L) at MMM02-2 (354 µg/L average) and MMM02-3 (951 µg/L);
- Trichloroethene (TCE) was detected at a concentration of 267 µg/L in borehole MMM02-5, the MOE Guideline criterion for TCE is 50 µg/L.;
- Cis-1,2-dichloroethene (c-DCE) was detected at a concentration of 351 µg/L in borehole MMM02-5 (MOE criterion is 70 µg/L).
- Vinyl Chloride (VC) was detected at concentrations ranging from 26.8 µg/L to 108 µg/L, in boreholes MMM02-4 and MMM02-5. The MOE criterion for VC is 1.3.

Concentrations above the CCME criteria were detected for benzene at MMM02-1 (5.8 µg/L) and MMM02-3 (37.1 µg/L), TCE at MMM02-5 (267 µg/L), and VC at MMM02-4 (39 µg/L average) and MMM02-5 (108 µg/L).

Vinyl chloride, which is a breakdown product of TCE and some other chlorinated hydrocarbons was detected during this study, but is not documented in previous studies completed in the early 1980s. It is not known whether this compound was tested for and not detected, or was not tested for. The presence of vinyl chloride may indicate some degradation of chlorinated compounds.

5.2.3 Polycyclic Aromatic Hydrocarbons (PAHs)

No exceedances were detected in groundwater during the subsurface investigation for

PAHs (Table 8c).

5.3 Surface Water Quality

The surface water analytical results were compared to the Provincial Water Quality Objectives (PWQO) and the CCME water/community criteria. Metal exceedances were detected in both Montgomery Creek and Basin 3 (Table 6). No VOC exceedances were detected in surface water, only traces of benzene, toluene and total xylenes were detected (Tables 9b). Previous studies detected exceedances for benzo(g,h,i)perylene, benzo(k)fluoranthene, DDT, fluoranthene, and total PCBs in Basin 3.

5.3.1 Metals

Nine metals were detected in surface water in the study area. Aluminium and lead exceeded the CCME criteria at all sample locations. Similarly, copper was found in concentrations above the PWQO at all locations except for MMM02-BS3(M). Iron, phosphorus and zinc were detected in concentrations above the criteria in all samples taken at the Montgomery Creek. Exceedances in cadmium, chromium, and cobalt were detected only at sample MMM02-SS1, taken upstream from the Montgomery Creek. Zinc concentrations above the criterion was also detected at MMM02-BS1, taken on the north corner of Basin 3.

Previous studies had identified concentrations above the criteria for chromium, cooper, iron, lead and zinc in water from the Montgomery Creek, and copper, lead and zinc in water from Basin 3.

6.0 EVALUATION OF FINDINGS

The 2002 analytical results indicate concentrations above the provincial and federal guideline criteria for metals and VOCs in soil and groundwater, and metals in surface water. Historical data indicates that sediments in the Montgomery Creek and Basin 3 are also impacted.

6.1 Metals

Results show metal impacts in the soil are present across the former dumpsite. Elevated concentrations above the MOE and/or CCME criteria for antimony, arsenic, barium, cadmium, chromium, chromium (vi), cobalt, copper, lead, nickel, and zinc were detected. The soil samples were recovered from depths ranging from 0 to 3 metres below grade and are mostly described as sandy/silty fill. The vertical distribution of the impact has not been evaluated in detail, but it likely extends to 4 m below ground (the extent of the waste). Soil metal contamination likely originated from the waste in the dumpsite.

Elevated concentrations of metals were also detected in the groundwater. Concentration above the criteria for antimony, iron, manganese, nickel, and zinc were detected and are likely leaching from wastes.

Metals concentrations above the criteria were also detected in surface water from both Montgomery Creek and Basin 3. In Montgomery Creek, it was observed that the metal concentrations upstream are higher than those adjacent to the site and downstream, indicating that the old dumpsite may not be the source of metal impacts of the surface water of Montgomery Creek. Metal concentrations in Basin 3 are within the same range across the Basin. Cadmium, lead, zinc and arsenic in soil and water is often associated with waste sites. Cadmium, lead and arsenic may effect human health, even in low concentrations.

No chemical exceedances were detected from soils obtained from the testpits advanced to the west of Basin 3.

6.2 Volatile Organic Compounds

VOCs exceedances were detected in soil and groundwater. While VOCs impacted soils were detected only at sampling location MMM02-2 (ethylbenzene and total xylenes), VOC impacted groundwater was found in five of the six sampling locations (benzene, ethylbenzene, total xylenes, TCE, c-DCE, and VC).

Benzene, ethylbenzene and xylenes may be associated with gasoline (fuel) which may be associated with boats which use the harbour. They are commonly found in waste sites and landfills when discharged as used solvent, or in varnish, pain, or in paint thinners. They are colourless chemicals with a sweet odour that evaporate easily into the air and are relatively soluble in groundwater.

Volatilisation, dissolution, sorption and degradation by microorganisms influence the fate and transport of these compounds in the environment. Volatilisation is the first process that occurs when BTEX are released into the environment. Since BTEX are very soluble in

water, they tend to dissolve and move with groundwater. Sorption of BTEX takes place between the organic compounds and the soil particles trapping and controlling the spreading of the pollutants.

Trichloroethene (TCE), cis-1,2 dichloroethene (c-DCE), and vinyl chloride (VC) are chlorinated organic compounds that often occur together in the environment. TCE has been used for dry cleaning, metal cleaning and degreasing of equipment and machinery. TCE is a common cause of environmental impacts at many industrial facilities for it was used and released into the environment in large quantities between 1950 and the early 1980s (DeVane 1998). Anaerobic biodegradation of TCE occurs through progressive dechlorination from trichlorethene to dichloroethene, vinyl chloride and ethene (Weaver 1996). Consequently the presence of vinyl chloride in soil and groundwater may indicate degradation of TCE under anaerobic conditions.

6.3 PCBs and PAHs

No exceedances for PAHs or PCBs were detected.

6.4 Summary of Findings

In summary:

- Metals at concentrations which exceed the selected criteria were found in soil and groundwater across the site. Metal impacts were also detected in surface water from both Basin 3 and Montgomery Creek.
- VOCs at concentrations which exceed the selected criteria were found in soil and groundwater. Benzene, ethylbenzene and total xylenes were detected in soil and groundwater at the east edge of the site along Montgomery Creek. Chlorinated compounds (TCE, c-DCE, and VC) were detected in groundwater at the western part of the site at sample locations MMM02-4 and MMM02-5.
- TPHs were found in concentrations above the MOE criteria in soil at three sample locations.
- No exceedances for PAHs or PCBs were detected.
- The quality of the surface water in Montgomery Creek tends to be better downgradient of the dumpsite then upgradient of the dumpsite.
- Conditions observed in 2002 are not noticeably different than those observed in 1984. Elevated concentrations of metals, chlorinated hydrocarbons and volatile organic compounds are present and have been in the soil and groundwater since investigations began in the 1980s.

7.0 REMEDIATION REQUIREMENTS

Release or likely release of toxic substances to the environment is considered a violation of the *Canadian Environmental Protection Act.* According to the Act, release includes seepage. Toxic substances are defined in the act and include vinyl chloride and lead, both of which are present at the site, and may be being released into the harbour. The fact that these compounds are present at elevated concentrations in the groundwater at MMM02-04 located at the edge of Basin 3 may be considered a trigger to require mitigation of these impacts. We note that federal guidance documents recommend consideration of onsite management techniques, and evaluation of these methods in comparison to potential impacts caused through removal and relocation of the waste or contaminated soils.

There are federal and provincial requirements to mitigate any adverse effects or deleterious effects to Montgomery Creek and the harbour. Failure to do so may be in violation of the *Fisheries Act*, the *Canadian Environmental Protection Act*, the *Environmental Protection Act* of Ontario and the *Ontario Water Resources Act*.

Based on the drilling and sampling completed to date, we have not found direct evidence of an adverse effect due to the presence of the dumpsite. Although the water and sediment quality in Montgomery Creek and the Basin do not meet some criteria, there is no direct correlation between the presence of the dumpsite and the impacts that we have observed.

Additional ecological studies, or a risk assessment may be necessary to evaluate adverse effects at the site.

An environmental sensitivity ranking of the subject site, as outlined in the National Classification System for Contaminated Sites was conducted. Detailed Evaluation Forms are included as Appendix D. Based on the National Classification System, we have assigned a classification of 2 to the site. At this classification, there is a high potential for adverse off-site impacts, although the risk is not considered imminent. Action is likely required, although the method of action is not stipulated. According to the guidelines, action may include risk management and site remediation.

According to the *Guideline for Use at Contaminated Sites in Ontario*, remediation may be required if a change of land use (i.e., zoning change) is considered. Therefore, if the site is to be redeveloped in a manner that will change the land use and involve a zoning change, remediation will be required.

These guidelines also state that the MOE may order a cleanup using their own discretion if they evaluate that an adverse effect is probable (or even possible). It has been our experience that MOE will not require onsite impacts be addressed, but may order remediation of offsite impacts.

Although not stipulated in the regulations, if the site is to be sold, the purchasers of a site may require remediation as a condition of sale of the property. However, these negotiations are usually an issue between the purchasers and seller, and the regulators generally do not get involved in these negotiations.

According to the *Provincial Water Quality Objectives,* there are water quality impairments in Montgomery Creek and the Harbour. These impacts may or may not be attributable to the dumpsite, however, the objectives state that where surface water is impacted, further degradation is not permitted.

There is currently no requirement to perform an Environmental Assessment under the Canadian Environmental Assessment Act. We understand that if the Harbour Commission becomes a Port Authority, CEAA may apply.

According to *A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites* (May 1998) a buffer zone is required along the perimeter of any new or expanding landfill sites. However, these guidelines do not apply to existing dumpsites and therefore it is our interpretation that the site does not have to be retrofitted with a buffer.

Based on the *Guideline for Use at Contaminated Sites in Ontario*, the site may be considered a sensitive site, due to the proximity to Montgomery Creek and the harbour, which are considered fish habitat. Therefore, consultation with the local MNR or conservation authority may be required to evaluate whether the generic criteria are appropriate. The consultation may indicate that the chemical criteria obtained from the soil and groundwater from the site should be compared to background criteria to assess the site. Background criteria could be site specific background criteria, or Table F of the *Guideline for Use at Contaminated Sites in Ontario*.

In summary, the site impacts should be addressed, according to provincial and federal legislation. The method to address these impacts is not specified by the regulators.

8.0 REMEDIAL ALTERNATIVES

We considered several generally practical and cost effective and proven alternatives for addressing the impacts at the site. In considering the alternatives, we reviewed the technology, we developed a basic conceptual strategy, considered the regulatory acceptability and estimated the cost.

8.1 Excavation and Disposal

8.1.1 Overview

One option is to remove the waste associated with the dumpsite and dispose of the waste at a registered landfill. In order to assess this option, we developed a conceptual plan to implement excavation and disposal of the waste, which is as follows:

- Obtain necessary permits from the CLOCA, to allow for the excavation of soil along the riverbank.
- Install silt curtains at the mouth of the marina, and isolate a portion of Montgomery Creek.
- Block seepage from the Creek and the harbour into the dumpsite, by installation of sheet piling or a low permeability barrier along Montgomery Creek and Basin 3, to a typical depth of 4 metres.
- Construct stormwater diversions, such as ditches, around upgradient sides of the excavation area.
- Begin excavation at the upgradient side of the dumpsite and work southerly, to minimise the influx of surface or groundwater.
- Remove and segregate clean cover (approximately 0.3 metres) for subsequent reuse on site.
- Extend the excavation into the water table. Constantly de-water the excavation once below the water table. Pump effluent through a treatment system and discharged back into the harbour or, preferably, discharge directly to the sanitary sewer,
- Backfill the excavation progressively with purchased material or dredge material to minimise the volume of water requiring treatment,
- Assuming that the wastes are not hazardous, haul the impacted soil to a disposal or recycling site. It is estimated that approximately 2500 truck loads would leave the site over approximately 30 days,
- Dispose of the material as waste, unless other options can be developed.
- Once backfilling is complete, re-vegetate and maintain siltation control until vegetation is re-established.

It is recognised that a portion of the dumpsite extends under Basin 3; auger drilling which was completed to a depth of 0.3 metres under the floor of Basin 3 was terminated in waste. MMM84-10, which was advanced at the northeast edge of Basin 3, indicated that waste

extended to a depth of 2.3 metres. Therefore, for complete waste removal, a portion of the base of Basin 3 will also likely have to be removed. A possible method of accomplishing this would be as follows:

- Install siltation control at the mouth of Basin 3.
- Remove the sediments (without de-watering the basin), using either an excavator on a barge, or clamshell dredge equipment (note: environmental dredge equipment, such as the cable arm system may be required, depending on the predicted concentration of sedimentation and the quality and quantity.)
- Transfer the sediments to shore using a small barge.
- Backfill the excavation with clean soil or recovered dredge material and allow backfill material to settle and compact naturally.
- Dewater the excavated material on shore, until it can be placed in trucks and then haul to a disposal site. Manage the entrained water in a method to reduce or minimise any impacts.

Extensive engineering design considerations would be required to facilitate excavation and disposal of the dumpsite. The following items would require consideration:

- Excavation directly adjacent to Montgomery Creek would need to be completed in a manner that would not generate silt and impact the Creek. It would require negotiation and permitting with the MNR and CLOCA.
- Because of the proximity to the lake and the creek, extensive dewatering will likely be required. This water will either be treated and discharged to the lake, directed untreated to the sanitary sewer, or treated and directed to the sanitary sewer. A treatment system may be required. The capacity of the sewer to handle this effluent must be evaluated. Possible effects on the creek and the lake during the dewatering (such as drawdown) must also be evaluated.
- The waste must be evaluated to confirm that it does not contain pockets or zones of hazardous soils, which would require special treatment.
- Over 2,500 truckloads of waste will be removed. The capacity of the roads must be evaluated and the impacts on the neighbours and residents must be taken into consideration.
- Dust and odours may be generated during the removal and require controls.
- During the removal, the workers and the public may be exposed to waste, which may not occur if the soil remained in place. Procedures must be implemented which do not result in increased exposure, over leaving the waste in place.

8.1.2 Regulatory Requirements

It is our interpretation that there is no regulatory requirement to remove the dumpsite, provided that the effects can be mitigated. However, complete dumpsite removal is an effective way to minimise and remediate the impacts.

8.1.3 Cost Assessment

A cost for complete removal of the dumpsite is estimated to be between $3.7 million and $5.7 million assuming a local source of backfill will be used. The additional cost to dredge the waste out of Basin 3 is estimated to be between $1.3 million and $2.1 million. Therefore, the total cost to remove the waste is estimated at between $4.5 million and $7.1 million.

If the excavation can be backfilled with dredged material, the cost for complete removal of the dumpsite is estimated to be between $3.2 million and $5.0 million. The estimated cost to remove the waste from the basin is estimated to be between $1.0 million and $1.7 million. Therefore, the total cost to remove the waste is estimated to be between $4.2 million and 6.7 million, if dredged material is used as backfill.

The assumption which were used to develop these estimates are included in Appendix G.

8.2 Containment System

8.2.1 Overview

In the 1984 report prepared by our office, we recommended containment as an alternative to complete removal for managing the impacts. The concept that was recommended consisted of the following:

- Remove surface debris, concrete blocks, piping, drums, etc.
- Re-channel Montgomery Creek to the east so that exposed drums and waste could be covered and resurface with clay,
- Cover the site with 0.6 metres of clay soil, graded not less than 1%, which extends under Montgomery Creek (The grading reduces the potential for surface water to infiltrate into the waste and therefore generate leachate.)
- Take precautions to prevent gas movement into closed structures,
- Pump the groundwater and leachate from within the dumpsite site, and discharge the effluent to the sewer. This would draw down the water table and minimise the flow of leachate from the site to the Lake and to Montgomery Creek.

It is our opinion that this would be effective at reducing or eliminating the impacts. The majority of contaminants at the site are low mobility contaminants, such as metals and heavy oils. The concentration of volatile contamination is low. Since this contamination tends to remain adsorbed on the soil, remediation by isolation is often an effective way of managing the impacts. Management in place tends to be considerably less disruptive. Impacts can be reduced and effects can be minimised. Leachate that is generated from the site would be collected and influx into the waste will be reduced by application of the cover.

If isolation were to be considered, we recommend the following with respect to the recommendations made in 1984.

1. In addition to applying the clay cap, it would also likely be necessary to place 0.15

metres of topsoil, to facilitate vegetation and the development of root zones.

2. Re-channelling Montgomery Creek may be difficult and may result in unnecessary destruction of habitat. In addition, the topography rises steeply to the east, approximately 30 metres from the creek, which may mean extensive excavation would be required to allow for shallow side slopes from the creek to the top of the bank. A more effective option may involve:

   - temporarily blocking the creek using a flue dam, directing the water around the work area while the remediation is conducted, and then remove the flue dams and restore the creek in its current location, or
   - pulling back any surface garbage from shore during a drier time of year, without draining or drying the creek bed.
   - Using carefully placed and designed siltation curtains to minimise the potential for impacts on Montgomery Creek.

3. An evaluation of the most efficient method to cap and isolate the sediments will be required. The 1984 report recommended isolating the site using a clay barrier. The Oshawa Harbour Commission has a local source of clay/silt available (McAsphalt). There is approximately 60,000 m^3 available for use on the marina property. The material is approximately 21 to 33% clay and 24 to 39% silt. This material has a plasticity index of 8 to 12 % (SPT, 2002). Based on the high clay content, this material would be suitable for use as a capping material.

4. An evaluation of the most efficient method to capture the leachate will be required. The recommendation in 1984 was for capturing the leachate from one central pump located in the centre of the dumpsite. We conducted groundwater flow modelling using FLOWPATH to evaluate the effects of pumping at the site with respect to capturing groundwater. A description of the modelling methodology and parameters used is included in Appendix E. Figure 5a shows the current groundwater flow at the site. Figure 5c shows the modelled effect of a single pumping well with an average production of 8.6 m^3/d. This rate of pumping generates a groundwater depression in the central part of the site, but does not capture the entire plume. Alternative pumping arrangements can be done using 3 pumping wells with lower pumping rates (3 m^3/d) as shown in Figure 5d. This pumping arrangement will allow a more spaced groundwater depression and larger capture area.

   A more efficient alternative to pumping wells is the construction of a shallow collection trench extending parallel to Basin 3 up and along a portion of Montgomery Creek. This collection system would be installed at a depth of approximately 1.5 m below ground and could also be expanded north along Montgomery Creek. Figure 5e shows the drawdown effect of a trench parallel to Basin 3. Using this configuration, it is likely that the entire plume can be captured.

   In summary, the one central well is likely not the most effective way of controlling the plume. However, the plume can be controlled using alternative pumping configurations.

5. Several partially damaged and corroded drums were observed at surface of the site and

along the bank of Montgomery Creek during our site visit in 2002. Drums at surface should be removed and not buried, as originally recommended in 1984.

Engineering design considerations would be required to facilitate containment. The following items would require consideration:

- Unless the cover is extended approximately 30 to 40 metres into the basin, the dumpsite will not be fully covered. Extending the cover into the basin will restrict the dredging depth or future maintenance that may be required.
- Registration on the title of contamination in place would be required. This may restrict future land use, development and saleability of the site.
- To date, landfill gas has not been detected at elevated concentrations. Given the age of the site, and the high water table it is anticipated that gas is not being generated at elevated pressures or concentrations. However, if the waste is to be left in place, and the site is used for parkland, additional investigation, detailed design and modelling should be completed to verify that there will be no impacts to future site users. If gas is present, methods may be required to ensure that pressures do not develop underneath the cap, or landfill gas is not forced off site during the installation of the cap.

8.2.2 Regulatory Requirements

With a few modifications, the methodology proposed in 1984 meets the standards which are supplied in the *Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites* (May 1998). As previously mentioned, there is not a requirement for existing sites to meet this guideline unless they are being expanded, however, we are recommending that this be used as a standard to evaluate the options.

If this methodology were implemented in a manner that reduces or controls impacts, then it should meet the regulatory requirements.

8.2.3 Cost

The cost for capping the dumpsite (assuming clay is available and obtained from a local source, such as the McAsphalt site) is estimated to be between $100,000 and $200,000.

The cost for installation of a cut off trench, with pumps which discharges to the sanitary sewer is estimated to be between $185,000 and $300,000.

In addition, ongoing operation and maintenance would be required. This may cost approximately $20,000 to $50,000 per year and should be assumed to be an ongoing cost.

The assumption which were used to develop these estimates are included in Appendix G.

8.3 Additional Onsite Management Techniques

In addition to containment, there are certain other management techniques that could be used to minimise or mitigate the impacts. The section that follows outlines some of the methods that could be implemented to perform the mitigation of the site.

8.3.1 Establishment and Construction of Buffer Zone

Overview

A buffer zone of at least 30 metres will provide some protection between the harbour (and the creek) and the dumpsite. As the groundwater migrates through this buffer zone, any leachate impacts from the dumpsite may be attenuated, adsorbed or naturally degraded in this zone, which should improve water quality. The presence of a buffer zone also allows for monitoring of soil and groundwater conditions prior to impacting the basin and creek. A buffer zone could be constructed between the dumpsite and the harbour by infilling Basin 3. The basic concept would entail:

- Installing siltation control at the mouth of Basin 3, or alternatively, dam off the mouth of Basin 3,
- Importing silty soil fill or dredged sediment to the site from a local source,
- Blading or pushing the sediments into the basin, in a gradual manner which does not stir up bottom sediments,
- Installation of sheetpiling or gabion baskets at the mouth of Basin 3 to minimise the potential for the soil to wash away at the mouth of the harbour,
- Compacting using a sheepsfoot compactor or similar heavy equipment,
- Placing topsoil over the area and hydroseeding.

Relocation of Montgomery Creek could be completed to create a buffer between the dumpsite and the creek, however, the creek is considered habitat and relocation may result in considerable habitat destruction. At this time, relocation of the creek is not considered practical, however, isolation of the Creek could be achieved through the following means:

- Installation of a series of pumping wells or a leachate collection trench approximately 2 to 3 metres from the high water bank of the creek. This would result in a 2 to 3 metre buffer zone between the main part of the dumpsite and the creek. A 30-metre buffer zone is not possible at this location.

We modelled the site using the Biochlor Natural Attenuation Decision Support System Computer Model (version 1.0) developed by the United States Environmental Protection Agency. The purpose of the model was to evaluate the effect that development of a buffer zone would have on the contaminant levels leaving the site. The Biochlor model simulates dispersion, advection and biodegradation to answer the basic question of the distance a contamination plume will migrate before it is naturally attenuated to background concentrations. The model can simulate dispersion without biological degradation and with biological degradation.

The results of the analysis are included in Appendix F. If Basin 3 is infilled in its entirety, significant reduction of contamination will occur prior to the groundwater migrating to the harbour. However, the model indicates that even with a minimum 100 metre of buffer, the groundwater that is eventually discharging to the harbour would still be impacted above surface water criteria.

However, modelling performed with the computer program FLOWPATH has indicated that depending on the material used to infill Basin 3, it is possible that groundwater flow from the dumpsite will be directed entirely towards Montgomery Creek (away from Basin 2). Therefore, provided that the groundwater is intercepted at Montgomery Creek, infilling the Basin may minimise leachate migration towards the harbour.

A buffer zone will assist in minimising the impacts to the harbour, however, a buffer zone alone will not fully reduce the impacts to levels within the criteria.

Regulatory Requirements

The regulatory requirements for new landfills and landfill upgrades recommend establishment of a buffer zone. This is also discussed in the Reasonable Use Concept (Procedure B-7-1 and Guideline B-7). Within the buffer zone, there would be no sensitive receptors and development would not be permitted.

The above referenced guidelines pertain to new landfill sites only and do not apply to existing sites. It is very unlikely that the existing dumpsite would have been approved for use, based on the proximity to the harbour and the creek and the lack of available attenuation zones.

Hydrogeological Effects

As previously stated, groundwater flow is towards the southeast. We performed preliminary site modelling using the computer program FLOWPATH under a variety of infilling scenarios, to evaluate changes to the groundwater flow regime which may occur. Interpreting the results of preliminary groundwater modelling for the area, there may be minor changes in groundwater flow direction as a result of infilling Basin 3 with moderately permeable material, but the general groundwater flow direction will not change significantly. The flow remains to the southeast. (A flow gradient change towards the proposed development to the west will not occur, based on the model.) Figures 5a and 5b present the results of a preliminary modelling of the groundwater flow in the area using the FLOWPATH model.

Cost

If dredged material is used for the infilling of Basin 3, the cost is estimated to be between $125,000 and $250,000. These costs should be considered in addition to costs developed for some alternatives that manage the waste in place.

We have also evaluated the cost implications if the basin is infilled and then is re-excavated at a later time, due to eventual implementation of the Harbour Development Plan, as proposed by Malone Given Parsons Ltd. & Hotson Bakker Archtects. There would be additional costs incurred, because of the handling of the soil, which may exceed $250,000. However, it is not likely that extra disposal costs will be incurred because the sediments used as backfill will not likely become contaminated due to their association with the dumpsite. This is because the principle contaminants in the dumpsite are not highly mobile (i.e., metals and heavy oils). VOCs and leachate may migrate through the backfilled sediments depending on the final design. However, these compounds are soluble and will

not likely adsorb onto the soils at any appreciable concentration. Therefore, backfilling of the basin would not preclude further development as a basin at a later time.

8.3.2 Risk Assessment

Overview

The generic criteria which is presented in the guidelines and documents presents conservative exposure scenarios, which may not be relevant at the subject site (i.e., impacts on indoor air quality is not significant given the current level of development.) In the process of a risk assessment, site specific criteria is developed which may be less stringent that the generic criteria, resulting in less restoration required.

Regulatory Requirements

Risk assessments are acceptable methods of developing criteria for sites under provincial and federal guidelines. If restoration is completed to a site specific criteria that is developed as part of a risk assessment, this must be documented on title.

Cost

A risk assessment may cost in the range of $100,000. It should be mentioned that the risk assessment may result in no significant reduction of restoration requirements.

8.3.3 Isolated Hot Spot Removal

Overview

The site contains assorted chemical compounds, such as metals, PAHs, petroleum components, PCBs and chlorinated volatile organic compounds. Removal of some of the more toxic and mobile compounds, while leaving some of less mobile and persistent contaminants is one method of managing the impacts.

The report prepared by NWRI in 1984 concludes that there is strong bonding between contaminants and the soil/sediments. This implies that the metal contamination is not mobile, and may not present a risk if bound to the soils. However, there may be other contaminants that are more mobile and may generate hazardous byproducts during degradation. Removal of some hot spots, such as the chlorinated hydrocarbon plume, while leaving low mobility metal, PAH and PCB impacted soils in place may be a method to reduce the volume of soil requiring remediation, while reducing risks to users of the site and the environment.

We have identified a zone of chlorinated hydrocarbons in the vicinity of boreholes MMM02-05 and MMM02-04 that could be considered for removal, while the remaining contamination may be suitable to remain on site. In order to remove this plume, the volume of soil that has to be removed is anticipated to be in the range of 3,000 cubic metres. Additional testing and a risk assessment would likely be required to confirm that this is a reasonable approach.

Regulatory Requirements

If some contaminants are to remain in place, a site specific risk assessment is required to verify that the residual contamination is not a risk to any users of the site or the environment. This is an acceptable method, according to CCME and MOE guidelines for addressing site impacts.

Cost

The cost for removal of isolated hot spots can not be assessed until additional detailed delineation is completed and possibly a risk assessment is undertaken. However, for discussion purposes, we assume that the amount of soil requiring removal will be approximately 10% of the total volume required for full site restoration. Therefore the cost to remove hot spots would be in the range of $500,000 in addition to other management in place costs.

8.3.4 Land use Planning

Overview

If the dumpsite is left in place, land use-planning mechanisms may be required to minimise the potential for impacts. Land use planning may include some of the following elements:

- Restricting access to the former dumpsite site, such as day-use only.
- Restricting certain uses of the site, such as not allowing enclosed structures or buildings.
- Registration of the dumpsite on title.

Regulatory Requirements

Provincial legislation allows for risk management measures and land use planning tools to facilitate a site remediation in which some contamination is left on site.

Cost

The main cost associated with land use plan is the loss of alternative land use. A comparative dollar value is not assigned to this alternative.

9.0 RECOMMENDED ALTERNATIVE

In order to select the preferred alternative for managing the dumpsite, we developed a list of remediation objectives that should be met to minimise impacts and then selected the preferred alternative to address these objectives. The objectives are as follows:

- The preferred alternative should minimise the potential for leachate generation,
- The preferred alternative should minimise the potential for migration of leachate into Montgomery Creek,
- The preferred alternative should minimise the potential for migration of leachate into Oshawa Harbour,
- The preferred alternative should minimise the potential for waste exposure during a significant storm event,
- The preferred alternative should minimise the potential for public contact of waste by users of the site,
- The preferred alternative should minimise exposure during construction, and
- The preferred alternative should minimise traffic impacts during construction.

In addition, we identified overall feasibility, public acceptability, regulatory acceptability and long term maintenance as issues which require consideration during selection of the preferred alternative. The results of the assessment are summarised in Table 10.

Complete excavation of the dumpsite was identified as one method of meeting most of the remediation objectives. However, it is considered cost prohibitive and is not necessary the only alternative which can achieve all the remediation objectives. Based on this, we reviewed engineering controls to select which options would be required to achieve the highest proportion of remediation objectives.

There is no single engineering control that achieves all the remediation objectives. However, if multiple engineering controls are used as part of the overall preferred alternative, it is possible to meet all the remediation objectives and therefore minimise impacts from the dumpsite in a cost-effective manner.

The engineering controls which we have selected to meet the remediation objectives are listed below. We are of the opinion that the selection we have made will be effective and cost effective. The remediation alternative we are recommending would consist of:

- Grading and capping the dumpsite to minimise potential for leachate generation and to reduce the potential for contact between users of the site and the waste,
- Installing a groundwater interceptor between the dumpsite and Montgomery Creek to minimise the potential for leachate migration to Montgomery Creek,

- Complete infilling of Basin 3, to create a buffer to minimise migration of leachate to the harbour,
- Installation of storm water protection along the banks of Montgomery Creek to minimise the potential impacts in the event of a storm, and
- Land use controls, such as restricting access to the site and activities at the site to assist in minimising the exposure to users.

The preferred technology, is generally considered acceptable to the regulatory authorises, however, fish compensation, or other means of environmental mitigation may be necessary to implement this strategy (related to infilling of Basin 3). Some long-term maintenance will also be required.

The capital cost to implement these options will likely be between $500,000 and $1.0 million.

10.0 LIMITATIONS

This report has been prepared for the use by the Oshawa Harbour Commission in accordance with generally accepted environmental investigation practices. Any use of this report by any other party is the sole responsibility of such party. MMM accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The interpretation presented in this report is based on observations made during the site work and does not reflect any changes in conditions due to activities occurring at the Subject Property after the site work.

11.0 REFERENCES

Agency for Toxic Substances and Disease Registry 2001. *Frequently Asked Questions about Contaminants Found at Hazardous Waste Sites.* At http://www.atsdr.cdc.gov/toxfaq.html

Associated Geotechnical, borehole logs, 1960

Brennard, T.A., *Surficial Geology of the Oshawa Area*, NTS 30M/15, southern Ontario, Geological Survey of Canada, Open File 3331.

Canadian Council of Ministers of the Environment 1999. *Canadian Environmental Quality Guidelines.* Updated 2001.

Chapman and Putnam 1984. *The Physiography of Southern Ontario.* MNR

DeVane M.P.B., Wolf, R., and Early T.O. 1998. *DNAPL Source Remediation Demonstration.* Interagency DNAPL Consortium: at http://www.getf.org.

Environment Canada, *Oshawa Harbour Sampling Program (unpublished reports)*, 1981, 1982

Environment Canada, *Overview of Environmental Concerns in Oshawa Harbour Area*, 1983

Environment Canada, *Oshawa Harbour Pollution Prevention Demonstration Site*, 2000

Gartner Lee Associates, *Industrial Waste Site Identification*, 1980

Golder Associates, *Subsurface Investigation of Abandoned Waste Disposal Facility*, 1983

Malone Givens Parsons Ltd. & Hotson Bakker Architects, *Oshawa Harbour Urban Design Study,* 1995.

Marshall Macklin Monaghan, *Final Report on Subsurface Investigation of Durham Cruise Marina* , 1984

Marshall Macklin Monaghan, *Phase I and Phase II Environmental Site Assessment of the Oshawa Harbour Marina,* (currently unpublished)

Montgomery, John 1996. *Groundwater Chemicals: Desk Reference.* Lewis Publishers, Boca Raton, Florida.

National Water Research Institute, *Investigation of Chemical Concentrations of Durham Cruise Marina*, 1984

Ontario Ministry of the Environment 1996. *Guideline for Use at Contaminated Sites in Ontario, Revised in February 1997.* MOE

Ontario Ministry of the Environment 1998. *The Hydrogeology of Southern Ontario.* MOE

Shaheen Peaker Thompson Ltd., *Stockpile Investigation On Gifford Farm, Farewell Avenue South, Oshawa*, 1992

Sharpe et. al, 1997. *Surficial Geology of the Greater Toronto and Oak Ridges Moraine Area, Southern Ontario.* Ministry of Northern Development and Mines

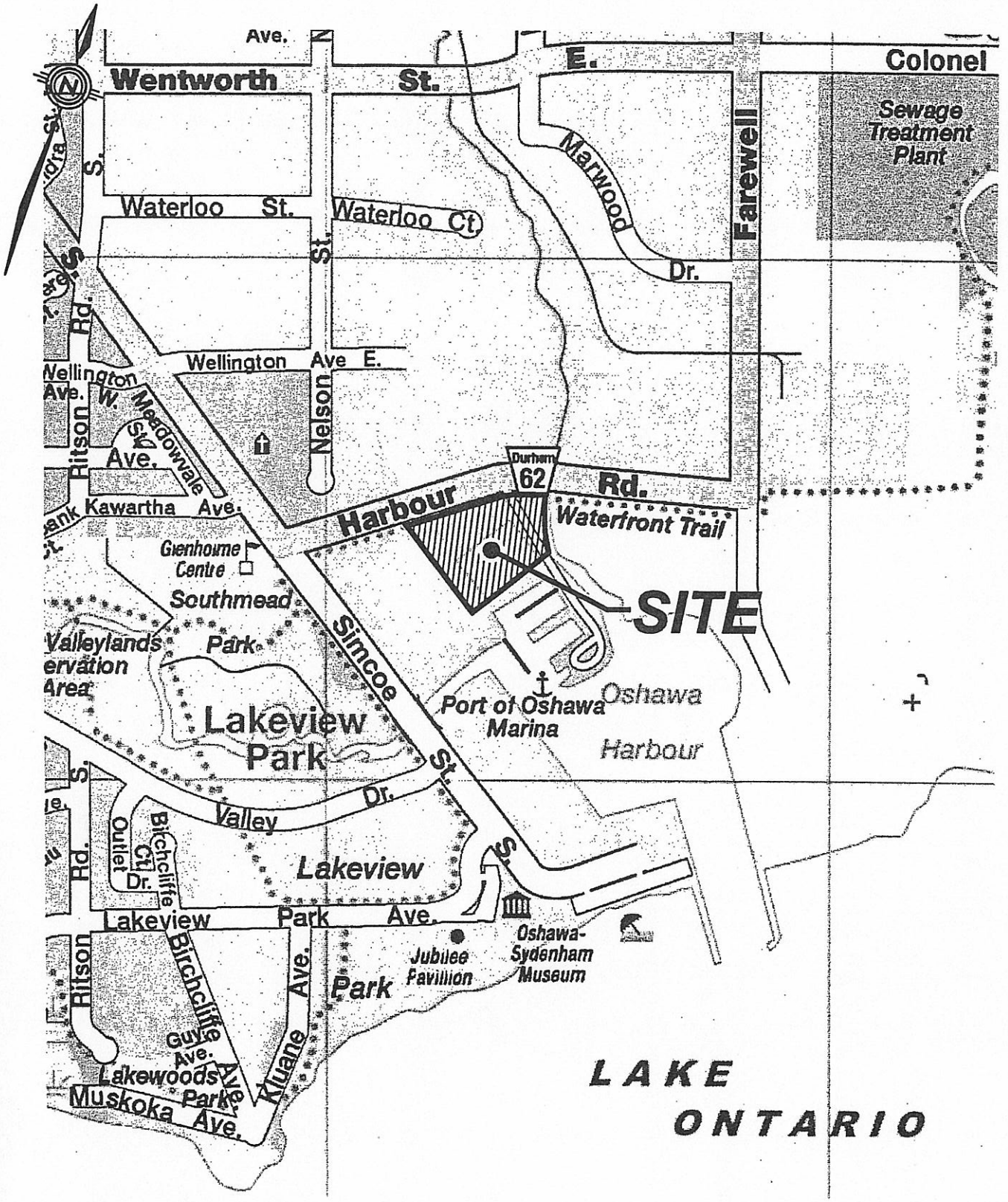
Verschueren, Karel 1983. *Handbook of Environmental Data on Organic Chemicals.* Van Nostrands Reinhold Company. New York.

Vulliame, Charles 2001. *DNAPLs in Groundwater.* Groundwater Protection & Restoration Group, University of Sheffied, UK: at http://www.shef.ac.uk/~dnapl/main.htm.

Weaver, J. W., Wilson, J.T. and Kampbell, D.H. 1996. *Extraction of Degradation Rate Constants from the St. Joseph, Michigan Trichloroethene Site.* Proceedings of the Symposium on Natural Attenuation of Chlorinated Organics in Groundwater September 1996. Dallas, Texas.

V.A. Wood Associated Limited, *Environmental Audit West Harbour Properties*, October 1993

FIGURES



MAP SOURCE: MAPART PUBLISHING CORPORATION

CLIENT

OSHAWA HARBOUR COMMISSION

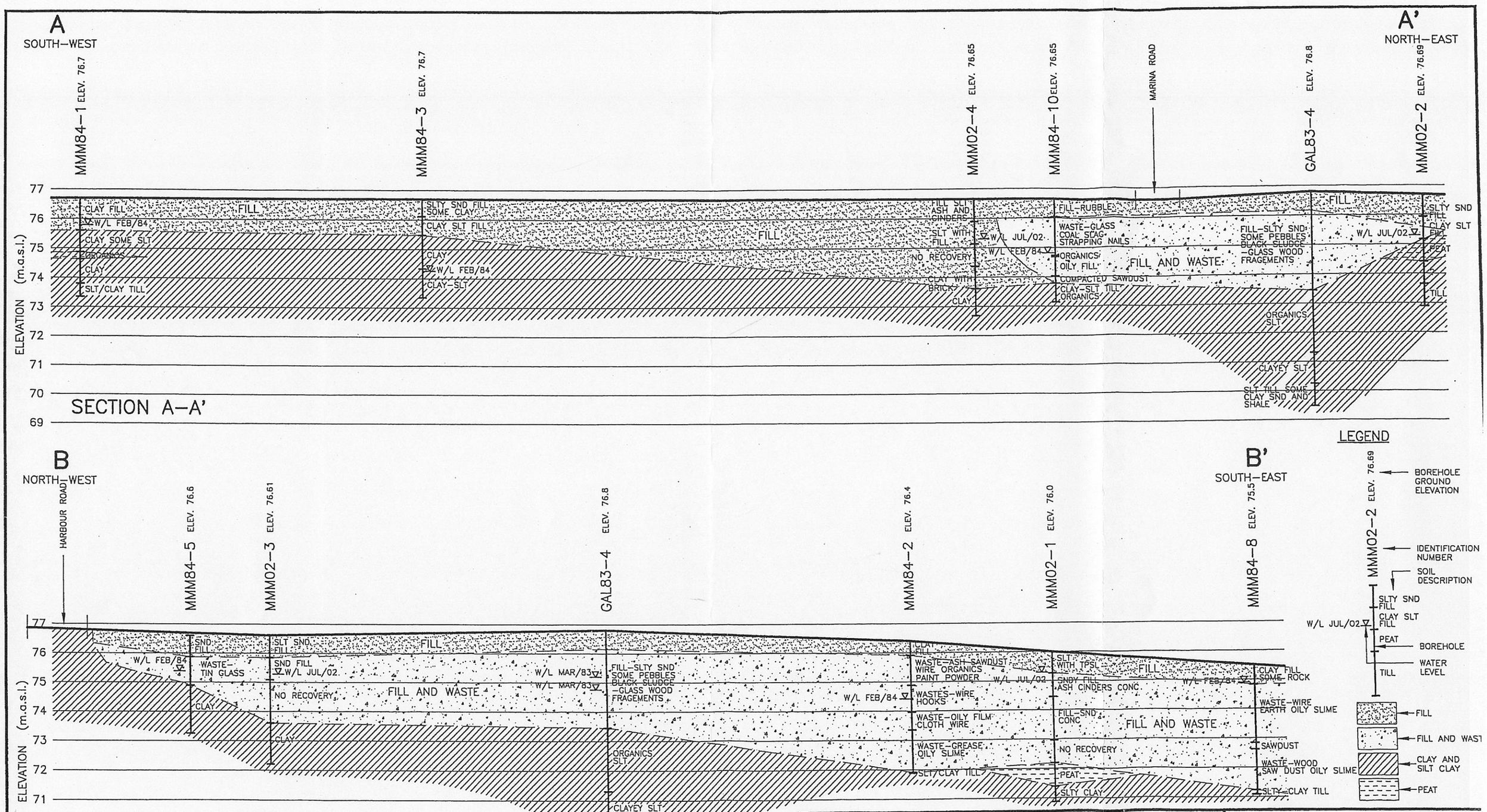
TITLE

SITE LOCATION

Marshall Macklin Monaghan

Project Managers . Engineers . Surveyors . Planners
80 Commerce Valley Dr. E, Thornhill, Ont. L3T 7N4
Tele (905)882-1100 Fax (905)882-0055

Checked C.M.	Drawn AutoCAD/B.K.B.
Date JULY 2002	Proj. No. 1402074-01-EM1
Scale N.T.S.	Figure No. 1 — Gr.No. 01



CLIENT

OSHAWA HARBOUR COMMISSION

TITLE

SECTION A–A' AND B–B'

Marshall Macklin Monaghan

Project Managers . Engineers . Surveyors . Planners

80 Commerce Valley Dr. E, Thornhill, Ont. L3T 7N4

Tele (905)882–1100 Fax (905)882–0055

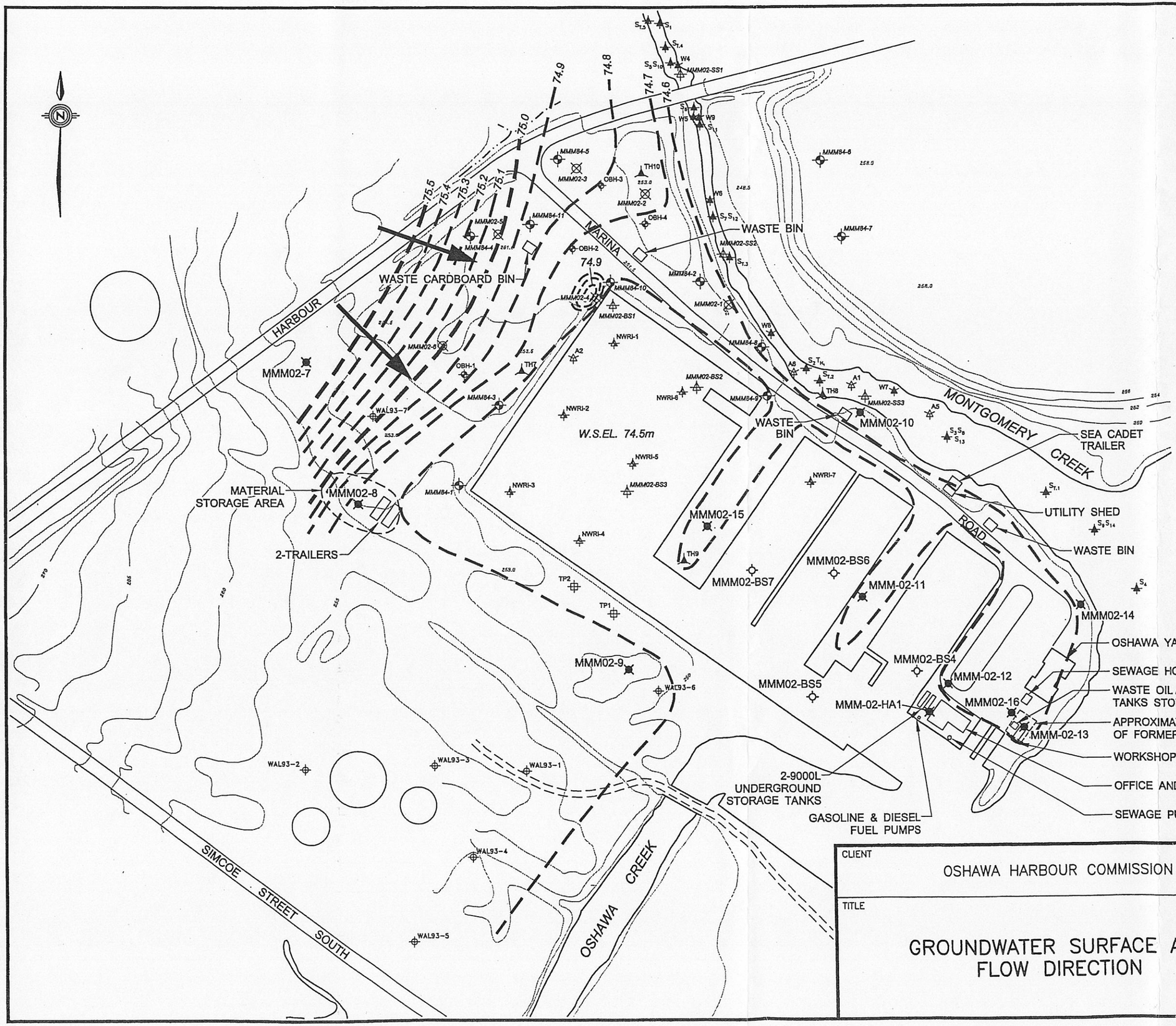
Checked C.M.	Drawn AutoCAD/G.K.
Date NOVEMBER 2002	Proj. No. 1402074–01–EM1
Scale AS SHOWN	Figure No. 3

SECTION B–B,

SECTION A–A

SECTION A–A, AND B–B,

OSHAWA HARBOUR COMMISSION



LEGEND

SAMPLING COMPLETED AS PART OF PREVIOUS INVESTIGATIONS

- OBH-1 — MONITORING WELL (DESTROYED) (GOLDER ASSOCIATES LTD.)
- MMM84-4 — MONITORING WELL (DESTROYED) (MARSHALL MACKLIN MONAGHAN LTD.)
- WAL93-1 — MONITORING WELL (DESTROYED) (V.A.WOOD ASSOCIATES LTD.)
- MMM02-3 — MONITORING WELL (MARSHALL MACKLIN MONAGHAN LTD. 2002)
- TP1 — TEST PIT (MARSHALL MACKLIN MONAGHAN LTD. 2002)
- MMM02-SS3 — SEDIMENT SAMPLE (MARSHALL MACKLIN MONAGHAN LTD. 2002)
- NWRI-2 — SEDIMENT SAMPLE (NATIONAL WATER RESEARCH INST.)
- W1* — SURFACE WATER SAMPLE (ENVIRONMENT CANADA 1983)
- TH9 — SEDIMENT SAMPLE (ENVIRONMENT CANADA 1983)
- S_4 — SEDIMENT SAMPLE (ENVIRONMENT CANADA 2000)
- A1* — SURFACE WATER SAMPLE (GARTNER LEE 1986)

SAMPLING COMPLETED AS PART OF THIS INVESTIGATION

- MMM02-10 — MONITORING WELLS (MMM FALL 2002)
- MMM02-BS4 — SEDIMENT SAMPLE (MMM FALL 2002)

* LOCATION ESTIMATED

— — 75.5 — PIEZOMETRIC SURFACE (m)

PRINCIPLE DIRECTION OF GROUNDWATER FLOW

NOTE: LOCATIONS OF FACILITIES ARE APPROXIMATE

CLIENT: OSHAWA HARBOUR COMMISSION

TITLE: GROUNDWATER SURFACE AND FLOW DIRECTION

Marshall Macklin Monaghan
Project Managers . Engineers . Surveyors . Planners
80 Commerce Valley Dr. E, Thornhill, Ont. L3T 7N4
Tele (905)882-1100 Fax (905)882-0055

Checked: K.H.	Drawn: AutoCAD/B.K.B.
Date: NOVEMBER 2002	Proj. No.: 1402074-01-EM1
Scale: AS SHOWN	Figure No.: 4 — Gr.No: 01

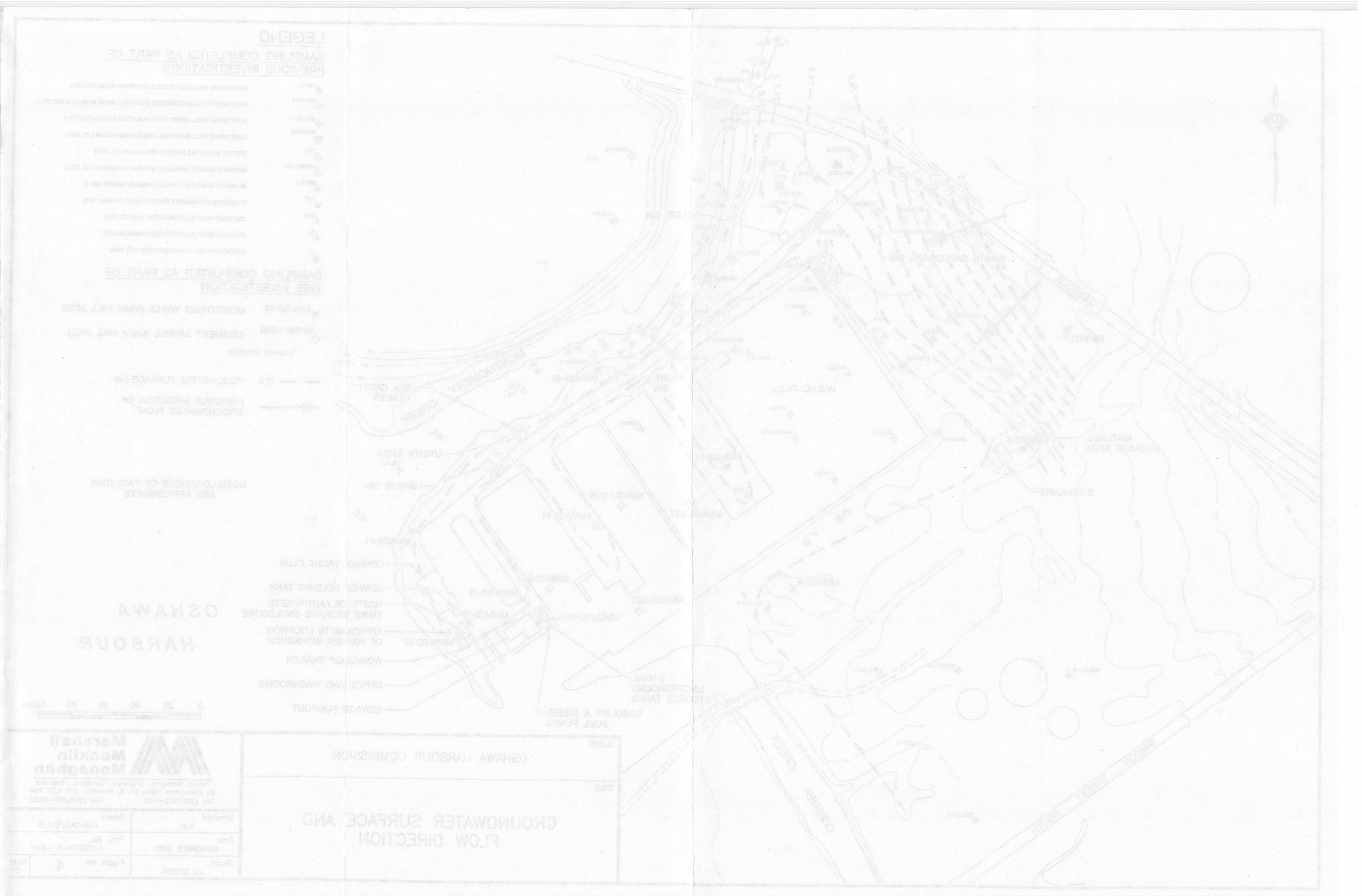

LEGEND
SAMPLING COMPLETED AS PART OF PREVIOUS INVESTIGATIONS
SAMPLING COMPLETED AS PART OF THIS INVESTIGATION
MONITORING WELLS (MMM FALL 2022)
SEDIMENT SAMPLE (MMM FALL 2022)
PIEZOMETRIC SURFACE (m)
PRINCIPLE DIRECTION OF GROUNDWATER FLOW
NOTE: LOCATIONS OF FACILITIES ARE APPROXIMATE
OSHAWA HARBOUR
0 20 40 60 80 100m
OSHAWA HARBOUR COMMISSION
GROUNDWATER SURFACE AND FLOW DIRECTION
Marshall Macklin Monaghan
Engineers, Planners
Drawn
Checked
Date
NOVEMBER 2022
Proj. No.
Scale
Figure No.
4

Figure 5a: Modeled Groundwater Flow

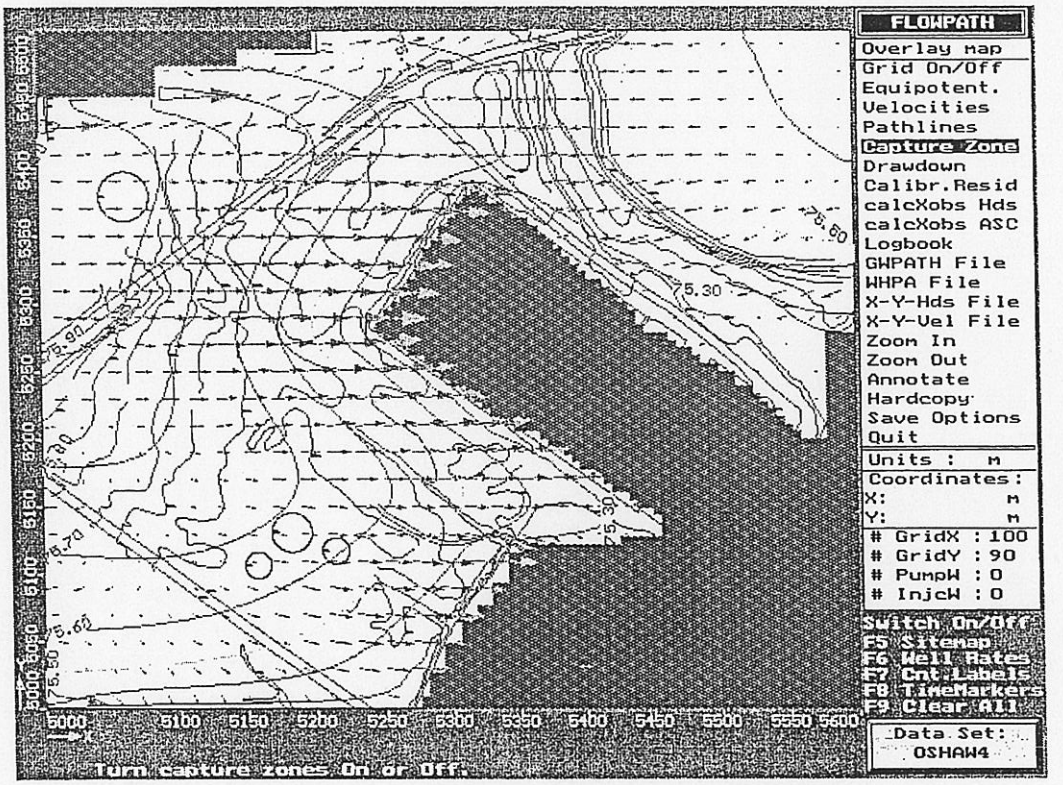


Figure 5b: Modeled Groundwater Flow with Basin 3 Infilled

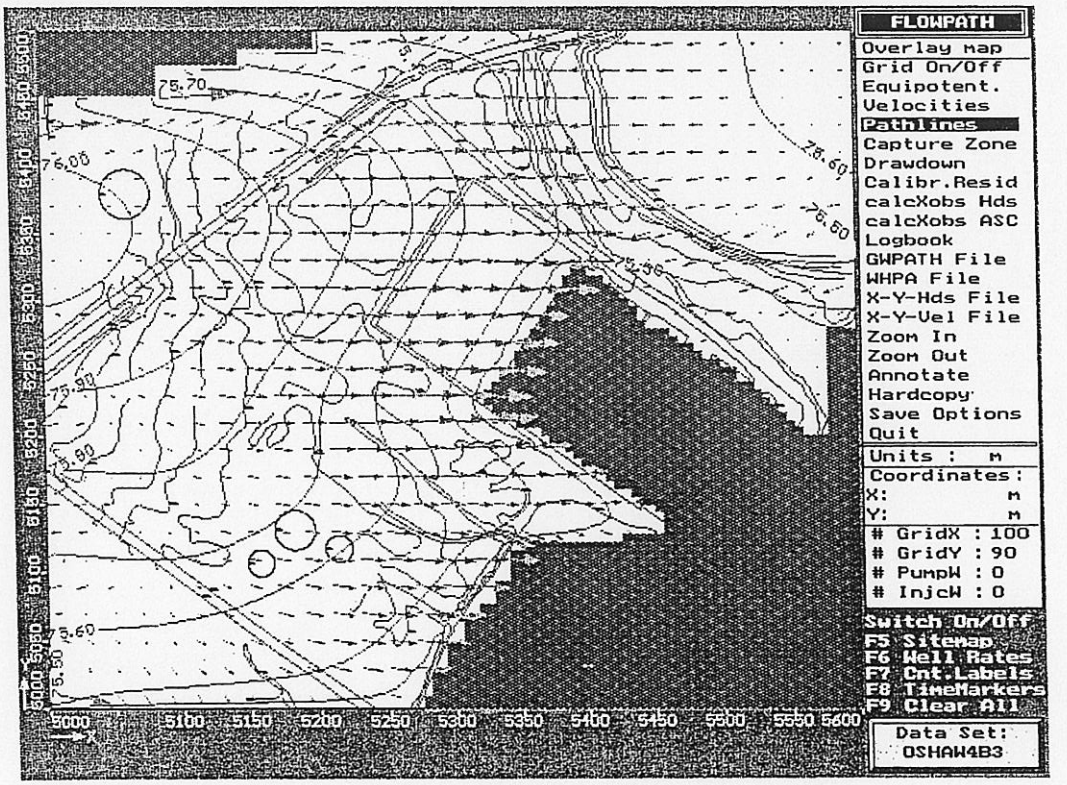


Figure 5c: Groundwater Flow with a Central Pumping Well

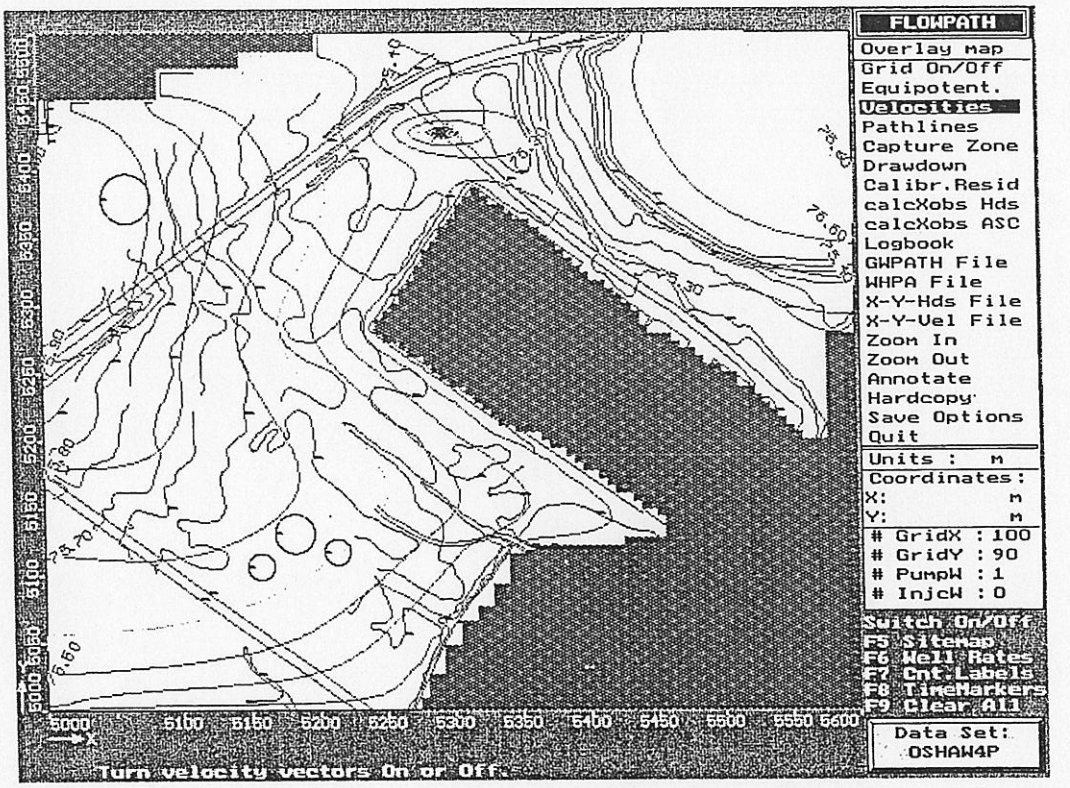


Figure 5d: Groundwater Flow with 3 Pumping Wells

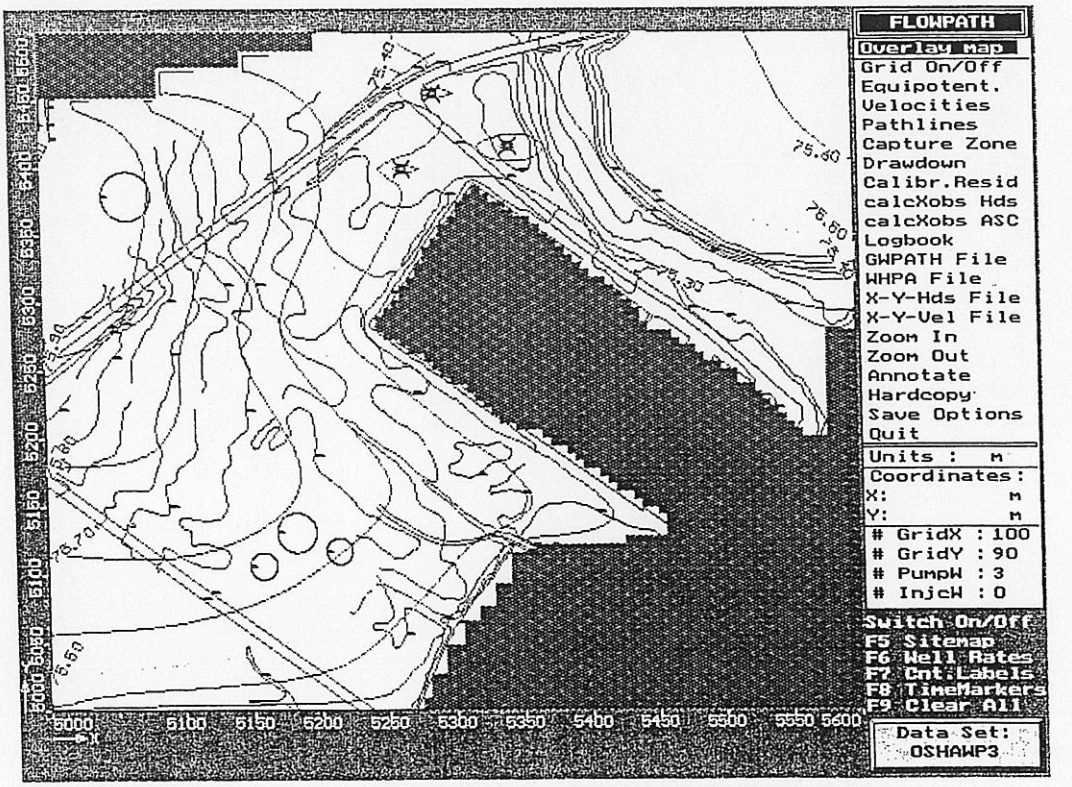
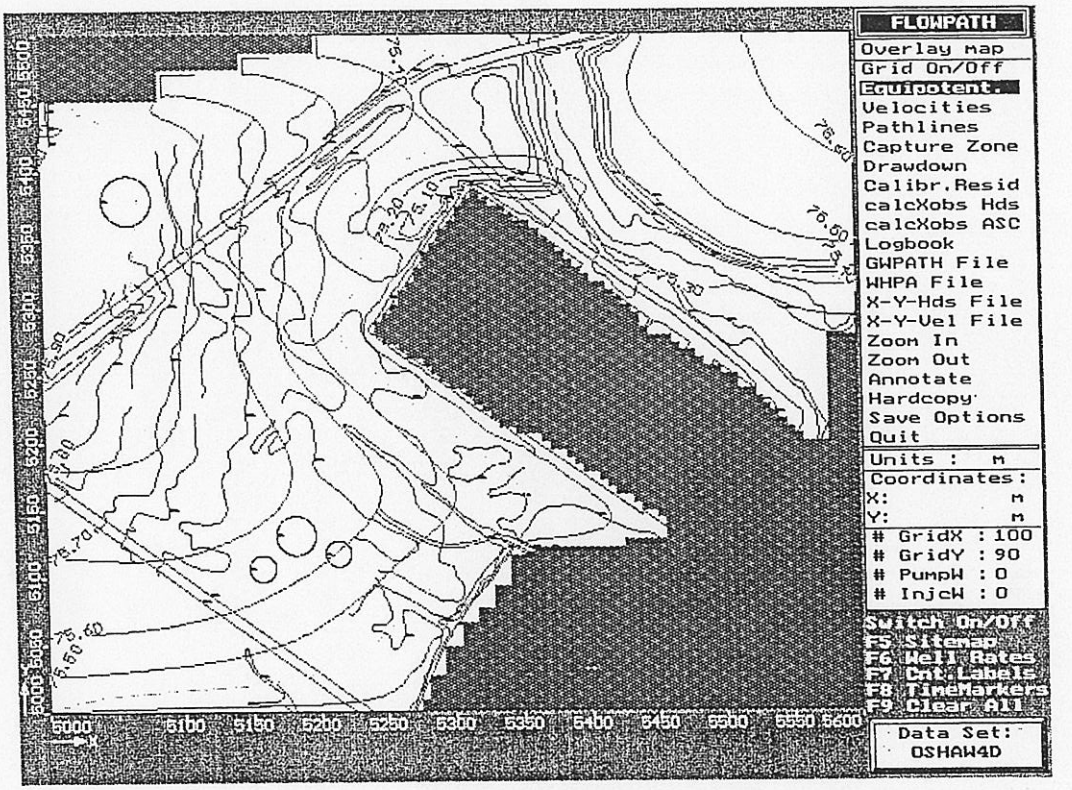


Figure 5e: Groundwater Flow with a Collection Trench



TABLES

Table 1a
Summary of Analytical Results for Oshawa Harbour
Sediment Quality Compared to Provincial Standards
General Chemistry

Parameter	LEL	SEL	Montgomery Creek																Harbour												
			Upgradient					North End of Landfill					South End of Landfill						Harbour Mouth				Basin 3								Basin 2
			St. 4	St. 5	S1	S5	S10	St. 3	S6	S7	S11	S12	St. 2	TH1	S2	S3	S8	S13	St. 1	S4	S9	S14	NWRI-1	NWRI-2	NWRI-3	NWRI-4	NWRI-5	NWRI-6	NWRI-6 core 0.07 to 0.13 m	NWRI-6 core 0.15 to 0.20 m	NWRI-7
			EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI
			2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	1984	1984	1984	1984	1984	1984	1984	1984	1984
Organic Carbon (%)	1	10	*2.263*	*1.575*				0.572					0.232						0.145												
Arsenic	6	23	2.5	*7.1*	*6.2*	2.2	2.5	2	5.1	*10.7*	2.9	*6.3*	1.9	*7.6*	*10*	4.6	3.2	*6.6*	1.5	3.4	0.83	1	4	4	1	*13*	*12*	*12*	*17*	*14*	*10*
Barium	-	-	140	120				68					36						32												
Beryllium	-	-	0.3	0.2				0.1					<0.1						0.1												
Boron	-	-	<10.0	<10.0				<10.0					<10.0						<10.0												
Cadmium	0.6	10	*2.9*	*1.8*				*1.4*					*0.8*						*1*												
Chromium	26	110	*140*	*130*	*160*	22	*56*	*93*	*230*	*340*	*43*	*53*	*70*	*630*	*310*	*130*	*180*	*170*	*38*	*110*	17	19	*73*	*82*	*64*	*64*	*70*	*126*	*188*	*191*	*74*
Cobalt	-	-	<5.0	<5.0	7			<5.0					<5.0	9.1	10.5	8.8			<5.0	4.5			5		1	1	3	6	5	52	1
Copper	16	110	*98*	*89*	*140*	*26*	*49*	*55*	*160*	*200*	*31*	*75*	*49*	*390*	*180*	*92*	*58*	*160*	*21*	*62*	10	10	*67*	*69*	*46*	*40*	*57*	*110*	*536*	*60*	*53*
Iron (%)	2	4	1.5	1.5				1.5					0.98						1												
Lead	31	250	*200*	*160*	*530*	11	*69*	*150*	*400*	*620*	*67*	*210*	*230*	*380*	*280*	*250*	*190*	*270*	*140*	*170*	*31*	18	*206*	*186*	*101*	*101*	*165*	*610*	*7800*	*1800*	*107*
Manganese	460	1100	370	340				360					260						180												
Mercury	0.2	2	*1.1*	*1.4*				*0.4*					0.08						0.05												
Molybdenum	-	-	1	1				1					<1.0						<1.0				0.11	0.13	0.09	0.1	0.09	0.17	0.03	0.03	0.11
Nickel	16	75	*71*	*64*	*77*	14	*32*	*40*	*140*	*200*	*22*	*45*	*32*	*330*	*420*	*85*	*140*	*100*	*28*	*69*	*20*	*22*	*86*	*88*	*65*	*66*	*81*	*105*	*45*	*45*	*94*
Phosporus	600	2000	*1100*	*980*				*800*					520						500												
Silver	-	-	2	1.7				<0.5					<0.5						<0.5												
Thallium	-	-	<20.0	<20.0				<20.0					<20.0						<20.0												
Vanadium	-	-	21	21				19					11						13				50	42	46	42	44	45	53	89	37
Zinc	120	820	*1000*	*890*	*2000*	65	*350*	*550*	*2000*	*2400*	*320*	*500*	*290*	*3100*	*4400*	*1400*	*720*	*1200*	*200*	*700*	96	90	*381*	*366*	*205*	*202*	*320*	*752*	*1335*	*539*	*206*
Total PCB	0.07	530	<0.051	<0.051	*0.43*	<0.051	<0.051	<0.051		*0.76*	<0.051	*0.56*	<0.051	0.03	*0.18*	*0.13*	*0.66*	0.04	<0.051	*0.2*	0.02	*0.08*		*0.12*				*0.15*	*0.15*		
Acenaphthene	-	-	<0.07	<0.07				<0.07					<0.07						<0.07												
Acenaphthylene	-	-	0.66	1.1				<0.04					<0.04						<0.04												
Anthracene	0.22	370	*0.67*	*0.99*				*0.34*					<0.03						<0.03												
Benzo(a)anthracene	0.32	1480	*2.2*	*2.7*				*1.3*					<0.02						<0.02												
Benzo(a)pyrene	0.37	1440	*4.2*	*5.3*				*2.3*					*0.57*						<0.05					0.089				0.16	0.05		0.17
Benzo(b)fluoranthene	-	-	3.1	4.1				1.5					0.48						<0.04												
Benzo(ghi)perylene	0.17	320	*2.6*	*2.8*				*1.7*					<0.04						<0.04					0.1				0.11	0.1		0.1
Benzo(k)fluoranthene	0.24	1340	*2.2*	*2.8*				*1.7*					*0.58*						<0.04					0.031				0.071	0.02		0.055
Chrysene	0.34	460	*2.6*	*3.4*				*1.6*					*0.57*						<0.03												
Dibenzo(ah)anthracene	0.06	130	<0.04	<0.04				<0.04					<0.04						<0.04												
Fluoranthene	0.75	1020	*3.7*	*4.2*				*2.3*					*1.1*						<0.02					0.18				0.41	0.066		0.48
Fluorene	0.19	160	<0.03	*0.51*				<0.03					<0.03						<0.03												
Indeno(1,2,3-cd)pyrene	0.2	320	*2.1*	*2.6*				*1.5*					<0.06						<0.06					0.066				0.13	0.04		0.11
Naphthanlene	-	-	0.78	0.82				0.46					<0.04						<0.04												
Phenanthrene	0.56	950	*2.2*	*2.9*				*1.4*					<0.03						<0.03												
Pyrene	0.49	850	*4.2*	*6.2*				*2.4*					*0.89*						<0.03												
Total PAH	2	11000	*21.21*	*40.42*				*18.5*					*4.19*						0												

Notes:
All units in ug/g unless otherwise stated
LEL: Lowest Effect Level: Guidelines from the Protection and Management of Aquatic Sediment in Ontario, Aug 1993

SEL: Severe Effect Level: Guidelines from the Protection and Management of Aquatic Sediment in Ontario, Aug 1993

EC: Data from Environment Canada Report
NWRI: Data from National Water Research Institute

100	Exceeds ISQG Criteria
100	Exceeds both ISQG and PEL

Note: Environment Canada reported data as 0

Table 1b
Summary of Analytical Results for Oshawa Harbour
Sediment Quality Compared to Federal Standards
General Chemistry

Parameter	ISQG	PEL	Montgomery Creek																Harbour													
			Upgradient					North End of Landfill					South End of Landfill						Harbour Mouth				Basin 3									Basin 2
			St. 4	St. 5	S1	S5	S10	St. 3	S6	S7	S11	S12	St. 2	TH1	S2	S3	S8	S13	St. 1	S4	S9	S14	NWRI-1	NWRI-2	NWRI-3	NWRI-4	NWRI-5	NWRI-6	NWRI-6 core 0.07 to 0.13 m	NWRI-6 core 0.15 to 0.20 m	NWRI-7
			EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	EC	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI
			2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	1984	1984	1984	1984	1984	1984	1984	1984	1984
Organic Carbon (%)	-	-	2.263	1.575				0.572					0.232						0.145												
Arsenic	5.9	17	2.5	*7.1*	*6.2*	2.2	2.5	2	5.1	*10.7*	2.9	*6.3*	1.9	*7.6*	*10*	4.6	3.2	*6.6*	1.5	3.4	0.83	1	4	4	1	*13*	*12*	*12*	*17*	*14*	*10*
Barium	-	-	140	120				68					36						32												
Beryllium	-	-	0.3	0.2				0.1					<0.1						0.1												
Boron	-	-	<10.0	<10.0				<10.0					<10.0						<10.0												
Cadmium	0.6	3.5	*2.9*	*1.8*				*1.4*					*0.8*						*1*												
Chromium	37.3	90	*140*	*130*	*160*	22	*56*	*93*	*230*	*340*	*43*	*53*	*70*	*630*	*310*	*130*	*180*	*170*	*38*	*110*	17	19	*73*	*82*	*64*	*64*	*70*	*126*	*188*	*191*	*74*
Cobalt	-	-	<5.0	<5.0	7			<5.0					<5.0	9.1	10.5	8.8			<5.0	4.5			5		1	1	3	6	5	52	1
Copper	35.7	197	*98*	*89*	*140*	26	*49*	*55*	*160*	*200*	31	*75*	*49*	*390*	*180*	*92*	*58*	*160*	21	*62*	10	10	*67*	*69*	*46*	*40*	*57*	*110*	*536*	*60*	*53*
Iron (%)	-	-	1.5	1.5				1.5					0.98						1												
Lead	35	91.3	*200*	*160*	*530*	11	*69*	*150*	*400*	*620*	*67*	*210*	*230*	*380*	*280*	*250*	*190*	*270*	*140*	*170*	31	18	*206*	*186*	*101*	*101*	*165*	*610*	*7800*	*1800*	*107*
Manganese	-	-	370	340				360					260						180												
Mercury	0.17	0.486	*1.1*	*1.4*				*0.4*					0.08						0.05				0.11	0.13	0.09	0.1	0.09	*0.17*	0.03	0.03	0.11
Molybdenum	-	-	1	1				1					<1.0						<1.0												
Nickel	-	-	71	64	77	14	32	40	140	200	22	45	32	330	420	85	140	100	28	69	20	22	86	88	65	66	81	105	45	45	94
Phosporus	-	-	1100	980				800					520						500												
Silver	-	-	2	1.7				<0.5					<0.5						<0.5												
Thallium	-	-	<20.0	<20.0				<20.0					<20.0						<20.0												
Vanadium	-	-	21	21				19					11						13				50	42	46	42	44	45	53	89	37
Zinc	-	-	1000	890	2000	65	350	550	2000	2400	320	500	290	3100	4400	1400	720	1200	200	700	96	90	381	366	205	202	320	752	1335	539	206
Total PCB	0.0341	0.277	<0.051	<0.051	*0.43*	<0.051	<0.051	<0.051		*0.76*	<0.051	*0.56*	<0.051	0.03	*0.18*	*0.13*	*0.66*	*0.04*	<0.051	*0.2*	0.02	*0.08*		*0.12*				*0.15*	*0.15*		
Acenaphthene	0.00671	0.0889	<0.07	<0.07				<0.07					<0.07						<0.07												
Acenaphthylene	0.00587	0.128	*0.66*	*1.1*				<0.04					<0.04						<0.04												
Anthracene	0.0469	0.245	*0.67*	*0.99*				*0.34*					<0.03						<0.03												
Benzo(a)anthracene	0.0317	0.385	*2.2*	*2.7*				*1.3*					<0.02						<0.02												
Benzo(a)pyrene	0.0319	0.782	*4.2*	*5.3*				*2.3*					*0.57*						<0.05					*0.089*				*0.16*	*0.05*		*0.17*
Benzo(b)fluoranthene	-	-	3.1	4.1				1.5					0.48						<0.04												
Benzo(ghi)perylene	-	-	2.6	2.8				1.7					<0.04						<0.04					0.1				0.11	0.1		0.1
Benzo(k)fluoranthene	-	-	2.2	2.8				1.7					0.58						<0.04					0.031				0.071	0.02		0.055
Chrysene	0.0571	0.862	*2.6*	*3.4*				*1.6*					*0.57*						<0.03												
Dibenzo(ah)anthracene	0.00622	0.135	<0.04	<0.04				<0.04					<0.04						<0.04												
Fluoranthene	0.111	2.355	*3.7*	*4.2*				2.3					*1.1*						<0.02					*0.18*				*0.41*	0.066		*0.48*
Fluorene	0.0212	0.144	<0.03	*0.51*				<0.03					<0.03						<0.03												
Indeno(1,2,3-cd)pyrene	-	-	2.1	2.6				1.5					<0.06						<0.06					0.066				0.13	0.04		0.11
Naphthanlene	0.0346	0.391	*0.78*	*0.82*				*0.46*					<0.04						<0.04												
Phenanthrene	0.0419	0.515	*2.2*	*2.9*				*1.4*					<0.03						<0.03												
Pyrene	0.053	0.875	*4.2*	*6.2*				*2.4*					*0.89*						<0.03												
Total PAH	-	-	21.21	40.42				18.5					4.19						0												

Notes:
All units in ug/g unless otherwise stated
< Not detected
ISQG: Interim Sediment Quality Guideline, *Canadian Environmental Quality Guidelines*, CCME, 1999
PEL: Probable Effect Level, *Canadian Environmental Quality Guidelines*, CCME, 1999
EC: Data from Environment Canada Report
NWRI: Data from National Water Research Institute
100 Exceeds ISQG Criteria
100 Exceeds both ISQG and PEL
Note: Environment Canada reported data as 0

Table 2a
Summary of Analytical Results for Oshawa Harbour
Historical Data
Soil Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	EC 1983							MMM - 1984			NRWI-1984							
			TH7 2 m	TH7 3 m	TH8 1 m	TH8 1.5 m	TH9 2 m	TH9 3 m	TH10 1.5 m	MMM84-7 3 m	MMM84-8 2.5 m	MMM84-11 2.5 m	OBH-1 3.82-3.97 m	OBH-2 1.53-1.93 m	OBH-2 4.58-5.03 m	OBH-3 0.76-1.22 m	OBH-4 2.29-2.75 m	OBH-4 3.05-3.51 m	OBH-4 0.5 m	OBH-4 0.7 m
Antimony	13	-																		
Arsenic	25	-	5.1	2.5	12.2	***140***	3.8	2.1	***63***				13	4	3	12	23	***39***	6	5
Barium	750	750								0.22	0.25	0.71								
Beryllium	1.2	-								<0.5	2.3	<0.5								
Cadmium	12	10																		
Chromium	1000	64	***130***	42	***110***	***150***	26	16	***370***	***949***	33.4	39.8	***71***	***178***	46	***2442***	***332***	***1714***	***488***	45
Chromium IV	8	0.4																		
Cobalt	50	-	8.4	8.6	7.2	14	6.3	3	46	<3	<3	<3	7	***82***	5	***221***	***140***	48	37	5
Copper	300	63	***97***	33	***150***	***230***	15	11	***2000***	62.1	***82.2***	60.5	33	***131***	30	***4772***	***124***	***2163***	***87***	25
Lead	200	140	***370***	100	***760***	***1900***	9.5	19	***840***	***280***	***1200***	93	45	***2600***	45	***40000***	***5700***	***7700***	***2700***	25
Mercury	10	-																		
Molybdenum	5	-								***20***	***20***	<1								
Nickel	200	50	***120***	46	***96***	***100***	14	8.5	***2400***	***181***	34	28	23	38	21	***84***	***108***	***112***	***57***	21
Selenium	10	-																		
Silver	20	-				-														
Vanadium	250	130								17.8	21.3	51.2	77	94	56	***246***	***133***	***230***	115	65
Zinc	800	200	***750***	***220***	***1000***	***3500***	60	4	***9900***	***530***	***654***	150	110	***3572***	91	***18982***	***41476***	***7822***	***1766***	69
Boron	1.5	-																		
Thallium	4.1	1								<0.5	<0.5	***16.4***								
Polychlorinate Biphenyls	0.5	1.3	0.08	<0.02	0.3	***2.4***	<0.02	<0.02	0.1	***1.4***	0.163	<0.001								

Notes:
All units in ug/g unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.

CCME: *Canadian Environmental Quality Guidelines* , CCME, 1999 for residential/parkland uses.

MMM: Data from Marshall Macklin Monaghan Report
NWRI: Data from National Water Research Institute Report
EC: Data from Environment Canada Report

100	Exceeds either Provincial or Federal Criteria

| | | |

Table 2b
Summary of Analytical Results for Oshawa Harbour
Historical Data
Soil Quality
Volatile Organic Compounds and Selected Pesticides Analysis

Parameter	MOEE Table A	CCME	NRWI-1984					
			OBH-1 3.82-3.97 m	OBH-2 1.53-1.93 m	OBH-2 4.58-5.03 m	OBH-3 0.76-1.22 m	OBH-4 2.29-2.75 m	OBH-4 3.05-3.51 m
1,1,1,2-tetrachloroethane	0.12	-						
1,1,1-trichloroethane	34	-						
1,1,2,2-tetrachlroethane	0.01	0.2						
1,1,2-trichloroethane	0.28	-						
1,1-dichloroethane	3	-						
1,1-dichloroethylene	0.015	-						
1,2,4-trichlorobenzene	30	-				0.001		0.001
1,2-dichlorobenzene	0.88	-		0.05			0.01	
1,2-dichloroethane	0.05	-						
1,2-dichloropropane	0.12	-						
1,3-dichlorobenzene	30	-	0.01	0.01	0.01		0.01	
1,4-dichlorobenzene	0.32	-				0.01	0.04	0.01
2-hexanone	-	-						
Acetone	3.5	-						
A-chlordane	0.29	-						0.002
Benzene	0.24	-						
Bromodichloromethane	0.12	-						
Bromoform	0.11	-						
Bromomethane	0.38	-						
Carbon tetrachloride	0.64	-						
Chlorobenzene	2.4	-						
Chloroethane	-	-						
Chloroform	0.13	-						
Chloromethane	-	-						
cis-1,2-dichloroethylene	2.3	-						
cis-1,3-dichloropropane	-	-						
Dibromochloromethane	0.09	-						
Dieldrin	0.05	-						0.006
Ethylbenzene	0.28	-						
Ethylene dibromide	0.01	-						
Fluoranthene	40	-	0.078	0.35	0.067	1.44	12.5	10.1
G-chlordane	0.29	-						0.004
Heptachlor epoxide	0.06	-				0.003	0.034	0.012
Hexachlorobenzene	0.46	-		0.002		0.003		0.012
Methyl ethyl ketone	0.27	-						
Methyl isobutyl ketone	0.48	-						
Methylene Chloride	1.1	-						
Methyl-tert-butyl-ether	5.7	-						
o,p-DDT	1.6	0.7						0.001
p,p-DDE	1.6	-	0.001	0.001	0.001	0.001	0.001	
p,p-DDT	1.6	0.7				0.003	0.028	0.036
Styrene	1.7	-						
Tetrachloroethylene	0.45	-						
Toluene	2.1	-						
Total PCBs	0.5	0.5				0.16	0.01	0.03
Total xylenes	25	-						
trans-1,2-dichloroethylene	4.1	-						
trans-1,2-dichloropropene	-	-						
Trichloroethylene	3.9	3						
Trichlorofluormethane	-	-						
Vinyl Chloride	0.0075	-						

Notes:
All units in ug/g unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.

CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

NWRI: Data from National Water Research Institute Report

100 Exceeds either Provincial or Federal Criteria

Table 2c
Summary of Analytical Results for Oshawa Harbour
Historical Data
Soil Quality
PAH Analysis

Parameter	MOEE Table A	CCME	NRWI-1984					
			OBH-1 3.82-3.97 m	OBH-2 1.53-1.93 m	OBH-2 4.58-5.03 m	OBH-3 0.76-1.22 m	OBH-4 2.29-2.75 m	OBH-4 3.05-3.51 m
1-Methylnaphthalene	1.2	-						
2-Methylnaphthalene	1.2	-						
Acenapthene	15	-						
Acenapthylene	100	-						
Anthracene	28	-						
Benzo(a)anthracene	6.6	-						
Benzo(a)pyrene	1.2	0.7	0.05	0.11	0.05	***0.75***	***2.32***	***4.52***
Benzo(b)fluroanthene	12	-	0.04	0.12	0.04	0.74	4.54	4.09
Benzo(ghi)perylene	40	-	0.1	0.14	0.1	0.5	6.25	3.45
Benzo(k)fluroanthene	12	-	0.02	0.093	0.02	0.37	2.54	1.37
Chrysene	12	-						
Dibenzo(a,h)anthracene	1.2	-						
Fluoranthene	40	-						
Fluorene	340	-						
Indeno (1,2,3-cd)pyrene	12	-	0.04	0.048	0.04	0.89	6.76	5.45
Napthalene	4.6	0.6						
Phenanthrene	40	-						
Pyrene	250	-						

Notes:
All units in ug/g unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.

CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

NWRI: Data from National Water Research Institute Report

100	Exceeds either Provincial or Federal Criteria

Table 3a
Summary of Analytical Results for Oshawa Harbour
Historical Data
Groundwater Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	OBH-1 NWRI 1984	OBH-2 NWRI 1984	OBH-3 NWRI 1984	OBH-4 NWRI 1984
Aluminum	-					
Antimony	6	6				
Arsenic	25	25				
Barium	1000	1000				
Beryllium	4	-				
Bismuth	-	-				
Boron	5000	5000				
Bromide		-				
Cadmium	5	5	1	1	1	1
Calcium	-	-				
Chloride	-	-				
Chromium	50	50	1	1	3	1
Cobalt	100	-				
Copper	23	-	8	11	***44***	***28***
Fluoride	-	-				
Iron	-	300				
Lead	10	10	1	1	1	2
Magnesium	-	-				
Manganese	-	50				
Mercury	0.12	1				
Molybdenum	7300	-				
Nitrate	-	45000				
Nitrite	-	3200				
Nickel	100	-	4	9	6	10
Phosphate	-	-				
Phosphorus	-	-				
Potassium	-	-				
Selenium	10	10				
Silicon	-	-				
Silver	1.2	-				
Sodium	-	-				
Strontium	-	-				
Sulphate	-	500000				
Thallium	2	-				
Tin	-	-				
Titanium	-	-				
Vanadium	200	-				
Zinc	1100	5000	15	25	39	36
pH (unitless)	6.5 - 8.5	-	6.8	7.1	7.1	8
DOC	-	-				
PCBs	-					
Hardness ($CaCO_3$)	-	-				
Sp Conductivity (umhos/cm)	-	-				
Chromium (VI)	50	50				

Notes:
All units in ug/L unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.

CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

NWRI: Data from National Water Research Institute Report

100 Exceeds either Provincial or Federal Criteria

Table 3a
Summary of Analytical Results for Oshawa Harbour
Historical Data
Groundwater Quality
Inorganic Analysis

Table 4a
Summary of Analytical Results for Oshawa Harbour
Historical Data
Surface Water Quality
Inorganic Analysis

Parameter	PWQO	CCME	Montgomery Creek								Harbour										
			W4	W5	W9	A6	A1	W7	W6	W8	A2	W3	W4	NWRI-1 average	NWRI-2 average	NWRI-3 average	NWRI-4 average	NWRI-5 average	NWRI-6 average	A5	NWRI-7 average
			EC	EC	EC	GL	GL	EC	EC	EC	GL	EC	EC	NWRI	NWRI	NWRI	NWRI	NWRI	NWRI	GL	NWRI
			1983	1983	1983	1980	1980	1983	1983	1983	1980	1983	1983	1984	1984	1984	1984	1984	1984	1980	1984
			upgradient	north end of landfill		south end of landfill			downgradient		landfill edge	Basin 3								Basin 2	
Aluminum	75	5					*2700*				1.3										
Antimony	20	-																			
Arsenic	5	5	1	1.2				1	1	0.9		0.9	0.9	0.9	1.3	1.1	1.4				
Barium	-	-																			
Beryllium	11	-																			
Bismuth	-	-																			
Boron	200	-																			
Bromide	-	-																			
Cadmium	0.1	0.017	<1	<1				<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1		<1
Calcium	-	-																			
Chloride	-	-																			
Chromium	100	8.9					*23*				*42*		5	3.75	2.5	3.5	2.75	2.67	4.67		2.67
Cobalt	0.6	-					<50				<50										
Copper	1	2	6	*9*	*10-28*		*23*	*8*	*13*	2	*28*	*3*	*10*	*11.75*	*10.75*	*25.25*	*14.5*	*12*	*7*		*15.65*
Fluoride	-	-																			
Iron	300	300			*490-4850*		*3000*				*13000*										
Lead	3	1	14	*27*	*3-130*			*24*	*23*	*4*		*6*	*3*	*2.75*	*2.5*	*2.75*	*3.5*	*2*	*2*		*3*
Magnesium	-	-																			
Manganese	-	-																			
Molybdenum	40	73																			
Nitrate	-	-																			
Nitrite	-	-																			
Nickel	25	-	5	8			20	7	10	3	*40*	6	7	10.5	10.5	10.5	10.5	11.67	11.33		11.33
Phosphate	-	-																			
Phosphorus	20	20																			
Potassium	-	-																			
Selenium	100	1																			
Silicon	-	-																			
Silver	0.1	0.1																			
Sodium	-	-																			
Strontium	-	-																			
Sulphates	-	-				50000	<50000				200000									0	
Tin	-	-																			
Titanium	-	-																			
Vanadium	6	6					<5				<5										
Zinc	20	20	76	*99*	*48-113*		*180*	*75*	*92*	13	*40*	8	4	*26*	14.25	16.5	12.5	9	9.67		7.67

PCBs	0.001	0.001	2	*3*				*1*	*2*	0		*60*	*10*								
TOC	-	-					70000				<1000										
conductivity (umhos/cm)	-	-				860	580				14000									470	
pH (unitless)	6.5 - 8.5	-				7.2	*5.5*				*5*									7.5	
Chloride	-	-			*94000-417000*	270000	90000				180000									90000	
Alkalinity ($CaCO_3$)	-	-				205000	51300				0									170000	
Hardness ($CaCO_3$)	-	-				223000	171000				325000									170000	

Notes:
All units in ug/L unless otherwise stated
PWQO: Ontario Ministry of the Environment and Energy, "Water Management: Policies, Guidelines, Provincial Water Quality Objectives," February 1999.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999.
GL: Data from Gartner Lee Report
NWRI: Data from National Water Research Institute Report
EC: Data from Environment Canada Report
Averages were calculated from samples collected over up to 7 sampling events.
100 Exceeds either Provincial or Federal Criteria

Table 4b
Summary of Analytical Results for Oshawa Harbour
Historical Data
Surface Water Quality
Volatile Organic Compounds, PAHs and Selected Pesticides Analysis

Parameter	PWQO	CCME	NWRI 1984 Basin 3 January '83	NWRI 1984 Basin 3 February '83	NWRI 1984 Basin 3 February '83	NWRI 1984 Basin 3 March '83
1,1,1,2-Tetrachloroethane	20	-				
1,1,1-Trichloroethane	10	-				
1,1,2,2-Tetrachloroethane	70	-				
1,1,2-Trichloroethane	800	-				
1,1-Dichloroethane	200	-				
1,1-Dichloroethene	40	-				
1,2,4-trichlorobenzene	0.5	24				
1,2-Dichlorobenzene	2.5	0.7	0.001	0.001	0.001	0.001
1,2-Dichloroethane	100	100				
1,2-Dichloropropane	0.7	-				
1,3-Dichlorobenzene	2.5	150	0.011	0	0	0
1,4-Dichlorobenzene	4	26	0.152	0.035	0.056	0.054
2-Hexanone	-	-				
Acetone	-	-				
Benzene	100	370				
Benzo(a)pyrene	-				0.5	
Benzo(b)fluoranthene	-				0.4	
Benzo(g,h,i)perylene	0.00002				***1***	
Benzo(k)fluoranthene	0.0002				***0.2***	
Bromodichloromethane	200	-				
Bromoform	60	-				
Bromomethane	0.9	-				
Carbon Tetrachloride	-	13.3				
Chlordane	0.06				0.0006	
Chlorobenzene	15	1.3				
Chloroethane	-	-				
Chloroform	-	1.8				
Chloromethane	700	-				
cis-1,2-Dichloroethene	200	-				
cis-1,3-dichloropropane	-	-				
cis-1,3-Dichloropropene	-	-				
DDD	-			0.0013		
DDT	0.003		0.0029	0.0026		***0.0058***
Dibromochloromethane	-	-				
Endrin	0.002		0.0001	0.0001	0.0001	0.0019
Ethylbenzene	8	90				
Ethylene dibromide	5	-				
Fluoranthene	0.0008				***0.6***	
Hexachlorobenzene	0.0065		0.001	0.001	0.001	0
Indeno(1,2,3-cd)pyrene	-				0.4	
Methyl Ethyl Ketone (MEK)	400	-				
Methyl Isobutyl Ketone (MIBK)	-	-				
Methylene Chloride	100	98.1				
Methyl-t-Butyl Ether	200	-				
Pentachlorobenzene	0.03		0.0001			0.0001
Styrene	4	72				
Tetrachloroethene	50	-				
Toluene	0.8	2				
Total PCB	0.001		1.7	***0.218***	***0.093***	***0.014***
Total Xylenes	2	-				
trans-1,2-Dichloroethene	200	-				
trans-1,2-dichloropropene	-	-				
trans-1,3-Dichloropropene	7	-				
Trichloroethene	20	21				
Trichlorofluoromethane	-	-				
Vinyl Chloride	600	-				

Notes:
All units in ug/L unless otherwise stated
Specific locations within the basin are unknown.
Zero values were reported as zero in the original data.
PWQO: Ontario Ministry of the Environment and Energy, "Water Management: Policies, Guidelines, Provincial Water Quality Objectives," February 1999.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999
NWRI: Data from National Water Research Institute Report
100 Exceeds either Provincial or Federal Criteria

Table 5
Summary of Water Level Information

Old Well ID	New Well ID	Date of Construction	Monitoring Well Depth (m)	Ground Elevation (m.a.s.l)	Monitoring Date	Depth to Water Below Grade (m)*	Piezometric Elevation (m.a.s.l)
OBH-1-1	GAL83-1-1	22-Mar-83	6.1	76.90	18-Apr-83	1.71	75.19
OBH-1-2	GAL83-1-2	22-Mar-83	3.6	76.90	18-Apr-83	1.74	75.16
OBH-1-3	GAL83-1-3	22-Mar-83	2.1	76.90	18-Apr-83	1.61	75.29
OBH-2-1	GAL83-2-1	22-Mar-83	6.1	76.80	18-Apr-83	1.28	75.52
OBH-2-2	GAL83-2-2	22-Mar-83	3.6	76.80	18-Apr-83	1.28	75.52
OBH-2-3	GAL83-2-3	22-Mar-83	2.1	76.80	18-Apr-83	1.49	75.31
OBH-3-1	GAL83-3-1	22-Mar-83	3.0	76.40	18-Apr-83	1.40	75.00
OBH-3-2	GAL83-3-2	22-Mar-83	1.5	76.40	18-Apr-83	1.25	75.15
OBH-4-1	GAL83-4-1	23-Mar-83	6.8	76.80	18-Apr-83	2.04	74.76
OBH-4-2	GAL83-4-2	23-Mar-83	2.6	76.80	18-Apr-83	1.71	75.09
P1	MMM84-1	13-Feb-84	3.4	76.70	5-Apr-84	0.91	75.79
P2	MMM84-2	13-Feb-84	4.6	76.40	5-Apr-84	1.98	74.42
P3	MMM84-3	13-Feb-84	3.4	76.70	5-Apr-84	2.44	74.26
P4	MMM84-4	13-Feb-84	3.5	77.00	5-Apr-84	0.46	76.54
P5	MMM84-5	13-Feb-84	3.4	76.60	5-Apr-84	1.22	75.38
P6	MMM84-6	14-Feb-84	3.4	78.65	5-Apr-84		
P7	MMM84-7	14-Feb-84	4.9	78.50	5-Apr-84	3.96	74.54
P8	MMM84-8	14-Feb-84	4.4	75.50	5-Apr-84		
P9	MMM84-9	12-Mar-84	3.4	76.00	5-Apr-84	1.52	74.48
P10	MMM84-10	12-Mar-84	3.5	76.65	5-Apr-84	1.83	74.82
P11	MMM84-11	12-Mar-84	3.2	76.70	5-Apr-84	2.44	74.26
BH-1	WAL93-1	12-Oct-93	5.0	77.30	12-Oct-93		
BH-2	WAL93-2	12-Oct-93	4.9	78.30	12-Oct-93	3.70	74.60
BH-3	WAL93-3	12-Oct-93	4.9	77.80	12-Oct-93	2.40	75.40
BH-4	WAL93-4	12-Oct-93	4.7	76.90	12-Oct-93	3.00	73.90
BH-5	WAL93-5	12-Oct-93	5.0	76.90	12-Oct-93	2.10	74.80
BH-6	WAL93-6	12-Oct-93	5.0	78.60	12-Oct-93		
BH-7	WAL93-7	12-Oct-93	5.0	78.70	12-Oct-93		
	MMM02-1	02-Jul-02	3.8	76.00	2-Jul-02	0.71	75.29
	MMM02-2	02-Jul-02	3.7	76.69	2-Jul-02	1.39	75.30
	MMM02-3	02-Jul-02	3.8	76.61	2-Jul-02	1.33	75.28
	MMM02-4	02-Jul-02	3.9	76.65	2-Jul-02	1.35	75.30
	MMM02-5	02-Jul-02	4.4	76.64	2-Jul-02	1.21	75.43
	MMM02-6	02-Jul-02	4.5	77.75	2-Jul-02	2.22	75.53
	Harbour				2-Jul-02		75.27
	MMM02-1	02-Jul-02	3.8	76.00	16-Sep-02	1.39	74.61
	MMM02-2	02-Jul-02	3.7	76.69	16-Sep-02	1.96	74.73
	MMM02-3	02-Jul-02	3.8	76.61	16-Sep-02	1.72	74.89
	MMM02-4	02-Jul-02	3.9	76.65	16-Sep-02	1.70	74.95
	MMM02-5	02-Jul-02	4.4	76.64	16-Sep-02	1.64	75.00
	MMM02-6	02-Jul-02	4.5	77.75	16-Sep-02	2.76	74.99
	MMM02-7	10-Sep-02	8.2	79.39	16-Sep-02	3.63	75.76
	MMM02-8	10-Sep-02	6.0	78.83	16-Sep-02	4.22	74.62
	MMM02-9	10-Sep-02	5.3	78.37	16-Sep-02	3.74	74.63
	MMM02-10	10-Sep-02	4.8	76.24	16-Sep-02	1.66	74.58
	MMM02-11	10-Sep-02	4.3	75.67	16-Sep-02	1.07	74.60
	MMM02-12	11-Sep-02	4.2	75.74	16-Sep-02	1.14	74.60
	MMM02-13	11-Sep-02	4.3	75.37	16-Sep-02	0.78	74.59
	MMM02-14	11-Sep-02	5.3	75.90	16-Sep-02	1.30	74.60
	MMM02-15	11-Sep-02	4.4	76.16	16-Sep-02	1.41	74.75
	MMM02-16	11-Sep-02	3.7	75.38	16-Sep-02	0.81	74.57
	Harbour				03-Oct-02		74.50

Table 6
Summary of Exceedances
Oshawa Harbour
2002 Sampling Program

Media	Substance	Parameters Exceeding Criteria	Sample ID	Measured Concentration (ug/g or ug/L)	Criteria Concentration (ug/g or ug/L)	Source of Criteria
Soil	Metals	Antimony	All but MMM02-6 SS1	36 - 756	13	MOEE Table A
		Arsenic	All but MMM02-6 SS1 and MMM02-4 SS4	33 - 42	25	MOEE Table A
		Barium	MMM02-4 SS1 and SS4	1200 - 1400	750	MOEE Table A
		Cadmium	All but MMM02-4 SS4 & MMM02-6 SS1	15.3 - 153	10	CCME
		Chromium	All but MMM02-6 SS1	73 - 1140	64	CCME
		Chromium VI	MMM02-4 SS4	2	0.4	CCME
		Cobalt	MMM02-2 SS2 and MMM02-3 SS2	75 - 117	50	MOEE Table A
		Copper	All but MMM02-6 SS1	147 - 3240	63	CCME
		Lead	All but MMM02-6 SS1	1390 - 18300	140	CCME
		Molybdenum	All but MMM02-6 SS1 and MMM02-4 SS4	7-41	5	MOEE Table A
		Nickel	All but MMM02-6 SS1 and MMM02-4 SS4	156 - 526	50	CCME
		Zinc	All but MMM02-6 SS1	1590 -34400	200	CCME
	VOCs					
		Ethylbenzene	MMM02-2 SS2	11.1	0.28	MOEE Table A
		Total xylenes	MMM02-2 SS2	51.8	25	MOEEE Table A
	TPH	Petroleum Hydrocarbon (gas/diesel)	MMM02-01 SS1, MMM02-04 SS4 & MMM02-05 SS1	130 - 260	100	MOEE
Groundwater	Metals	Antimony	MMM02-2, MMM02-3, MMM02-5	12 - 23	6	MOEE Table A
		Iron	MMM02-1, MMM02-2, MMM02-3, MMM02-4	6070 - 20600	300	CCME
		Manganese	All	830 - 4400	50	CCME
		Nickel	MMM02-2	118	100	MOEE Table A
		Zinc	MMM02-2	1110	1100	MOEE Table A
	VOCs	Benzene	MMM02-1 and MMM02-3	5.8 - 37.1	5	MOEE Table A/CCME
		Ethylbenzene	MMM02-1 and MMM02-3	24.5 - 54.8	2.4	MOEE Table A
		Total Xylenes	MMM02-1 and MMM02-3	350 - 961	300	MOEE Table A
		Trichloroethene	MMM02-5	267	50	MOEE Table A/CCME
		cis-1,2-Dichloroethene	MMM02-5	351	70	MOEE Table A
		Vinyl Chloride	MMM02-4 and MMM02-5	26.8 - 108	1.3	MOEE Table A
Surface Water	Metals	Aluminium	MMM02-SS1 (U), MMM02-SS2(M), MMM02-SS3(D), MMM02-BS1(E), MMM02-BS2(E), & MMM02-BS3(M)	34 - 2700	5	CCME
		Cadmium	MMM02-SS1 (U)	0.1 - 0.7	0.017	CCME
		Chromium	MMM02-SS1 (U)	18	8.9	CCME
		Cobalt	MMM02-SS1 (U)	1.2	0.6	MOEE (PWQO)
		Copper	MMM02-SS1(U), MMM02-SS2(M), MMM02-SS3(D), MMM02-BS1(E) & MMM02-BS2(E)	4.8 - 24	1	MOEE (PWQO)
		Iron	MMM02-SS1 (U), MMM02-SS2(M), MMM02-SS3(D)	430 - 4850	300	MOEE (PWQO) /CCME
		Lead	MMM02-SS1 (U), MMM02-SS2(M), MMM02-SS3(D), MMM02-BS1(E), MMM02-BS2(E), & MMM02-BS3(M)	1.3 - 38.4	1	CCME
		Phosphorus	MMM02-SS1 (U), MMM02-SS2(M), MMM02-SS3(D)	80 - 310	20	MOEE (PWQO) /CCME
		Zinc	MMM02-SS1 (U), MMM02-SS2(M), MMM02-SS3(D), & MMM02-BS1(E)	25 - 246	20	MOEE (PWQO) /CCME

Notes:
MOEE - Guideline for Use at Contaminated Sites in Ontario - Table A for Residential/Parkland Land Use
MOEE (PWQO) - Provincial Water Quality Objectives
CCME - Canadian Environmental Quality Guidelines

Table 7a
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	MMM-2002									
			MMM02-01 SS2 0.8 to 1.4 m	MMM02-02 SS2 0.8 to 1.4 m	MMM02-03 SS1 0 to 0.6 m	MMM02-03 SS2 0.8 to 1.4 m	MMM02-04 SS4 2.1 to 2.7 m	MMM02-04 SS1 0 to 0.6 m	MMM02-05 SS2 0.8 to 1.4 m	MMM02-06 SS1 0 to 0.6 m	Testpit 1 composite	Testpit 2 composite
Antimony	13	-	**185**	**402**	**700**	**756**	**36**	**43.1**	**52.9**	0.2	0.8	0.2
Arsenic	25	-	**42**	**40.3**	**35.9**	**40.3**	7.7	**33**	7.8	1.2	2	3
Barium	750	750	705	324	660	707	**1440**	**1200**	147	38	73	138
Beryllium	1.2	-	0.6	0.3	0.6	0.7	0.9	0.9	0.5	0.2	0.4	0.6
Cadmium	12	10	**99.6**	**66**	**153**	**69.1**	4.9	**28.1**	**15.3**	0.5	<0.5	<0.5
Chromium	1000	64	115	**1140**	524	694	601	81	73	8	17	28
Chromium IV	8	0.4	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Cobalt	50	-	19	**75**	33	**117**	34	13	13	3	5	8
Copper	300	63	**422**	**3240**	**1430**	**2750**	147	**367**	298	6	14	19
Lead	200	140	**6040**	**18300**	**13000**	**10200**	**2140**	**1740**	**1390**	8	45	15
Mercury	10	-	0.28	0.24	3.63	0.67	0.1	0.64	0.29	0.02	0.02	0.04
Molybdenum	5	-	**18**	**27**	**9**	**41**	3	**7**	4	3	<3	<3
Nickel	200	50	**355**	**404**	**526**	**286**	43	156	**319**	7	12	23
Selenium	10	-	6.5	1.1	3.1	2.4	0.4	3.3	1.5	0.2	<0.2	<0.2
Silver	20	-	3	4	4	4	<1	<1	<1	<1	<1	<1
Vanadium	250	130	32	21	34	41	56	28	32	15	22	34
Zinc	800	200	**34400**	**12100**	**7020**	**10600**	**1820**	**1590**	**1630**	36	53	64
Thallium	4.1	1	0.24	0.36	0.26	0.33	0.4	0.46	0.16	0.09	0.08	0.17
Boron	1.5	-	1.5	1.5	1.3	**2.3**	0.9	0.6	**4.4**	<0.2	0.6	0.6
Polychlorinated Biphenyls	0.5	1.3			<0.05			0.2				

Notes:
All units in ug/g unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.
100 Exceeds either Provincial or Federal Criteria

Table 7a
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	MM/MO2-01 SS2 0.8 to 1.4 m	MM/MO2-02 SS2 0.8 to 1.4 m	MM/MO2-03 SS1 0 to 0.6 m	MM/MO2-03 SS2 0.8 to 1.4 m	MM/MO2-04 SS4 2.1 to 2.7 m	MM/MO2-04 SS1 0 to 0.6 m	MM/MO2-05 SS2 0.8 to 1.4 m	MM/MO2-05 SS1 0 to 0.6 m	Test pit 1 composite	Test pit 2 composite
			MM/M-2002									
Antimony	13	-	185	402	709		36	45.1	32.9	0.2	0.8	0.2
Arsenic	25	-	42	40.3	35.9		7.7	23	7.9	1.2	2	
Barium	750	750	705	224	680		1440	1200	747	24	75	136
Beryllium	1.2	-	0.6	0.3	0.3		0.7	0.9	0.5	0.2	0.4	0.6
Cadmium	12	10	95.6	58	143		9.1	4.9	16.3	0.8	<0.5	<0.8
Chromium	1000	64	115	1140	524		624	61	79	8	11	26
Chromium IV	8	0.4	<4	<4	<4		<4	<4	<4	<4	<4	<4
Cobalt	50	-	10	13	23		177	34	18	3	8	9
Copper	300	63	4.72	2440	2350		2750	287	250	6	74	16
Lead	200	140	6046	19300	1390		19260	17460	2140	8	45	15
Mercury	10	-	0.28	0.24	2.82		0.27	0.24	0.23	0.12	0.02	0.04
Molybdenum	5	-	13	27	9		3	7	5	1	<3	<3
Nickel	200	50	585	164	526		280	169	349	7	12	23
Selenium	10	-	<5	1.1	3.1		0.4	3.2	1.6	0.2	<0.2	<0.2
Silver	20	-	3	4	4		<1	<1	<1	<1	<1	<1
Vanadium	250	130	32	21	24		41	25	39	15	22	24
Zinc	700	200	34406	12100	7020		10840	1220	1590	35	32	64
Thallium	1	1	0.24	0.38	0.38		0.4	0.25	0.79	0.05	0.09	0.17
Boron	1.5	-	1.3	1.5	1.5		2.3	0.9	0.9	4.4	<0.2	0.6
Polychlorinated Biphenyls	0.5	1.3			<0.05			0.2				

Notes:

All units in ug/g unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy, "Guidelines for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.

CCME: Canadian Environmental Quality Guidelines, CCME, 1999 for residential/parkland uses.

700 Exceeds either Provincial or Federal Criteria

Table 7a
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	MMM-2002									
			MMM02-01 SS2 0.8 to 1.4 m	MMM02-02 SS2 0.8 to 1.4 m	MMM02-03 SS1 0 to 0.6 m	MMM02-03 SS2 0.8 to 1.4 m	MMM02-04 SS4 2.1 to 2.7 m	MMM02-04 SS1 0 to 0.6 m	MMM02-05 SS2 0.8 to 1.4 m	MMM02-06 SS1 0 to 0.6 m	Testpit 1 composite	Testpit 2 composite
Antimony	13	-	**185**	**402**	700	756	36	**43.1**	**52.9**	0.2	0.8	0.2
Arsenic	25	-	**42**	**40.3**	**35.9**	**40.3**	7.7	**33**	7.8	1.2	2	3
Barium	750	750	705	324	660	707	**1440**	**1200**	147	38	73	138
Beryllium	1.2	-	0.6	0.3	0.6	0.7	0.9	0.9	0.5	0.2	0.4	0.6
Cadmium	12	10	**99.6**	**66**	**153**	**69.1**	4.9	**28.1**	**15.3**	0.5	<0.5	<0.5
Chromium	1000	64	115	**1140**	524	694	601	81	73	8	17	28
Chromium IV	8	0.4	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Cobalt	50	-	19	**75**	33	**117**	34	13	13	3	5	8
Copper	300	63	**422**	**3240**	**1430**	**2750**	147	**367**	298	6	14	19
Lead	200	140	**6040**	**18300**	**13000**	**10200**	**2140**	**1740**	**1390**	8	45	15
Mercury	10	-	0.28	0.24	3.63	0.67	0.1	0.64	0.29	0.02	0.02	0.04
Molybdenum	5	-	**18**	**27**	**9**	**41**	3	**7**	4	3	<3	<3
Nickel	200	50	**355**	**404**	**526**	**286**	43	156	**319**	7	12	23
Selenium	10	-	6.5	1.1	3.1	2.4	0.4	3.3	1.5	0.2	<0.2	<0.2
Silver	20	-	3	4	4	4	<1	<1	<1	<1	<1	<1
Vanadium	250	130	32	21	34	41	56	28	32	15	22	34
Zinc	800	200	**34400**	**12100**	**7020**	**10600**	**1820**	**1590**	**1630**	36	53	64
Thallium	4.1	1	0.24	0.36	0.26	0.33	0.4	0.46	0.16	0.09	0.08	0.17
Boron	1.5	-	1.5	1.5	1.3	**2.3**	0.9	0.6	**4.4**	<0.2	0.6	0.6
Polychlorinated Biphenyls	0.5	1.3			<0.05			0.2				

Notes:
All units in ug/g unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100	Exceeds either Provincial or Federal Criteria

Table 7b
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
Volatile Organic Compounds Analysis

Parameter	MOEE Table A	CCME	MMM-2002		
			MMM02-04 SS4 2.1 m to 2.7 m	MMM02-02 SS2 0.8 m to 1.4 m	MMM02-05 SS1 0 to .6 m
1,1,1,2-tetrachloroethane	0.12	-	<0.1	<1.0	<0.8
1,1,1-trichloroethane	34	-	<0.1	<1.0	<0.8
1,1,2,2-tetrachlroethane	0.01	0.2	<0.1	<1.0	<0.8
1,1,2-trichloroethane	0.28	-	<0.1	<1.0	<0.8
1,1-dichloroethane	3	-	<0.1	<1.0	<0.8
1,1-dichloroethylene	0.015	-	<0.1	<1.0	<0.8
1,2,4-trichlorobenzene	30	-	<0.1	<1.0	<0.8
1,2-dichlorobenzene	0.88	-	<0.1	<1.0	<0.8
1,2-dichloroethane	0.05	-	<0.1	<1.0	<0.8
1,2-dichloropropane	0.12	-	<0.1	<1.0	<0.8
1,3-dichlorobenzene	30	-	<0.01	21.4	<0.8
1,4-dichlorobenzene	0.32	-	<0.1	<1.0	<0.8
2-hexanone	-	-	<5.0	<50.0	<40.0
Acetone	3.5	-	<10.0	<100	<80.0
Benzene	0.24	-	<0.05	<0.5	<0.4
Bromodichloromethane	0.12	-	<0.1	<1.0	<0.8
Bromoform	0.11	-	<0.1	<1.0	<0.8
Bromomethane	0.38	-	<1.0	<10.0	<8.0
Carbon tetrachloride	0.64	-	<0.1	<1.0	<0.8
Chlorobenzene	2.4	-	<0.1	<1.0	<0.8
Chloroethane	-	-	nd	<5.0	<4.0
Chloroform	0.13	-	<0.1	<1.0	<0.8
Chloromethane	-	-	<1.0	<10.0	<8.0
cis-1,2-dichloroethylene	2.3	-	<0.1	<1.0	<0.8
cis-1,3-dichloropropane	-	-	<0.1	<1.0	<0.8
Dibromochloromethane	0.09	-	<0.1	<1.0	<0.8
Ethylbenzene	0.28	-	<0.01	***11.1***	<0.8
Ethylene dibromide	0.01	-	<0.1	<1.0	<0.8
Methyl ethyl ketone	0.27	-	<5.0	<50.0	<40.0
Methyl isobutyl ketone	0.48	-	<5.0	<50.0	<40.0
Methylene Chloride	1.1	-	<0.5	<5.0	<4.0
Methyl-tert-butyl-ether	5.7	-	<0.1	<1.0	<0.8
Styrene	1.7	-	<0.1	<1.0	<0.8
Tetrachloroethene	0.45	-	<0.1	<1.0	<0.8
Toluene	2.1	-	0.1	1.5	0.6
Total xylenes	25	-	0.1	***51.8***	<0.8
trans-1,2-dichloroethylene	4.1	-	<0.1	<1.0	<0.8
trans-1,2-dichloropropene	-	-	<0.1	<1.0	<0.8
Trichloroethylene	3.9	3	<0.1	<1.0	<0.8
Trichlorofluormethane	-	-	<0.1	<2.0	<1.6
Vinyl Chloride	0.0075	-	<0.5	<5.0	<4.0

Notes:
All units in ug/g unless otherwise stated

MOEE Table A: Ontario Ministry of the Environment and Energy "Guideline for Use at Contaminated Sites in Ontario," February 1997 agricultural land use, potable groundwater condition, fine to medium grained soils.

CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100 Exceeds either Provinicial or Federal Criteria

Table 7c
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
Total Petroleum Hydrocarbon Analysis

Parameter	MOEE Table A	CCME	MMM02-04 SS4 2.2 m to 2.8 m	MMM02-05 SS1 0 to 0.6 m	MMM02-01 SS2 0.8 to 1.4 m	MMM02-01 SS1 0 to 0.6 m	MMM02-03 SS5 3 to 3.6 m	MMM02-06 SS2 0.8 to 1.4 m
Petroleum Hydrocarbons (heavy oil)	1000	-	<100	400	970	<100	<100	<100
Petroleum Hydrocarbons (gas)	-	180	13	33	<10	<10	<10	<10
Petroleum Hydrocarbons (diesel)	-	250	120	***260***	230	<10	<10	<10
Petroleum Hydrocarbons (gas/diesel)	100	-	130	***260***	***230***	<10	<10	<10

Notes:
All units in ug/g unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997, Table A potable groundwater condition residential/parkland landuse, medium and fine textured soil.
CCME: *Canada Wide Standards for Petroleum Hydrocarbons in Soil*, CCME, January 2001, protection of potable groundwater, residential landuse, fine-grained subsoil.

100	Exceeds either Provincial or Federal Criteria

Table 7d
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
PAH Analysis

Parameter	MOEE Table A	CCME	MMM02-03 SS1 0 to 0.6 m	MMM02-03 SS5 3 to 3.6 m	MMM02-04 SS1 0 to 0.6 m	Testpit 1 composite	Testpit 2 composite
1-Methylnaphthalene	1.2	-	<0.2	<0.05	<0.2	<0.05	<0.05
2-Methylnaphthalene	1.2	-	<0.2	<0.05	<0.2	0.05	<0.05
Acenapthene	15	-	<0.2	<0.05	<0.2	0.05	<0.05
Acenapthylene	100	-	<0.2	<0.05	<0.2	<0.05	<0.05
Anthracene	28	-	0.11	<0.05	<0.2	0.21	<0.05
Benzo(a)anthracene	6.6	-	0.39	<0.05	0.16	0.44	<0.05
Benzo(a)pyrene	1.2	0.7	0.37	<0.05	0.15	0.36	<0.05
Benzo(b)fluroanthene	12	-	0.66	<0.05	0.20	0.54	<0.05
Benzo(ghi)perylene	40	-	0.38	<0.05	0.11	0.11	<0.05
Benzo(k)fluroanthene	12	-	0.22	<0.05	<0.2	0.19	<0.05
Chrysene	12	-	0.49	<0.05	0.15	0.43	<0.05
Dibenzo(a,h)anthracene	1.2	-	0.11	<0.05	<0.2	<0.05	<0.05
Fluoranthene	40	-	0.83	<0.05	0.34	1.19	<0.05
Fluorene	340	-	<0.2	<0.05	<0.2	0.06	<0.05
Indeno (1,2,3-cd)pyrene	12	-	0.37	<0.05	0.13	0.14	<0.05
Napthalene	4.6	0.6	0.22	<0.05	<0.2	0.05	<0.05
Phenanthrene	40	-	0.53	<0.05	0.22	0.70	<0.05
Pyrene	250	-	0.76	<0.05	0.28	0.92	<0.05

Notes:
All units in ug/g unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland landuse, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100	Exceeds either Provincial or Federal Criteria

Table 7e
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Soil Quality
PCB Analysis

Parameter	MOEE Table A	CCME	MMM02-03 SS5 3 to 3.6 m	MMM02-03 SS1 0 to 0.6 m	MMM02-04 SS1 0 to 0.6 m
Polychlorinated Biphenyls	0.5	1.3	<0.05	<1	0.2

Notes:
All units in ug/g unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland landuse, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100	Exceeds either Provincial or Federal Criteria

Table 8a
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Groundwater Quality
Inorganic Analysis

Parameter	MOEE Table A	CCME	MMM02-1 2002	MMM02-2 2002	MMM02-3 2002	MMM02-4 2002	MMM02-5 2002	MMM02-6 2002
Aluminum	-	-	7	<5	17	7	68	8
Antimony	6	6	4.1	***22.8***	***18.7***	4.8	***11.9***	<0.5
Arsenic	25	25	11	2	<2	<2	<2	<2
Barium	1000	1000	953	67	216	255	44	69
Beryllium	4	-	<1	<1	<1	<1	<1	<1
Bismuth	-	-	<1	<1	<1	<1	<1	<1
Boron	5000	5000	574	351	609	465	254	29
Bromide		-	<500	<500	<500	<500	<500	<500
Cadmium	5	5	<0.1	1.1	0.1	<0.1	<0.1	<0.1
Calcium	-	-	133000	197000	170000	127000	192000	200000
Chloride	-	-	87000	83000	203000	107000	132000	188000
Chromium	50	50	<5	<5	<5	<5	<5	<5
Cobalt	100	-	4	34.2	13.3	1.8	3.9	3.4
Copper	23	-	1.5	3.4	7.2	2.1	3.6	2.3
Fluoride	-	-	300	300	200	200	<100	<100
Iron	-	300	***20600***	***19000***	***6070***	***2110***	80	30
Lead	10	10	2	6	2.4	1.8	<0.5	0.8
Magnesium	-	-	32500	34000	23700	16600	40100	22000
Manganese	-	50	***1140***	***4400***	***1580***	***2870***	***830***	***1890***
Mercury	0.12	1						
Molybdenum	7300	-	14	8	11	1	17	14
Nitrate	-	45000	<200	<200	<200	<200	<200	<200
Nitrite	-	3200	<200	<200	<200	<200	<200	<200
Nickel	100	-	83	***118***	58	7	6	5
Phosphate	-	-	<1000	<1000	<1000	<1000	<1000	<1000
Phosphorus	-	-	360	<50	<50	70	<50	<50
Potassium	-	-	10800	7400	8600	1900	3200	2100
Selenium	10	10	<2	<2	<2	2	<2	<2
Silicon	-	-	8990	6050	7430	8180	9100	7710
Silver	1.2	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	-	-	43200	39300	105000	120000	73700	108000
Strontium	-	-	669	637	580	322	501	464
Sulphate	-	500000	46100	157000	95600	16300	188000	80400
Thallium	2	-						
Tin	-	-	<1	<1	<1	<1	<1	<1
Titanium	-	-	<5	<5	<5	<5	<5	<5
Vanadium	200	-	0.6	0.6	0.6	1	0.9	1.3
Zinc	1100	5000	39	***1110***	195	62	20	9
pH (unitless)	6.5 - 8.5	-	7.06	6.91	7.09	7.29	7.21	7.13
DOC	-	-	38.5	35.8	37.7	15.1	6	5.7
PCBs				<0.05		<0.05		
Hardness ($CaCO_3$)	-	-	466.6	634.1	522.9	386	646.2	591
Sp Conductivity (umhos/cm)	-	-	1094	1211	1455	1213	1364	1474
Chromium (VI)	50	50						

Notes:
All units in ug/L unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland landuse, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100	Exceeds either Provincial or Federal Criteria

Table 8b
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Groundwater Quality
Volatile Organic Compounds Analysis

Parameter	MOEE Table A	CCME	MMM02-1	MMM02-2	MMM02-2 Dup.	MMM02-3	MMM02-4	MMM02-4 Dup.	MMM02-5	MMM02-6
1,1,1,2-Tetrachloroethane	5	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,1,1-Trichloroethane	200	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,1,2,2-Tetrachloroethane	1	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
1,1,2-Trichloroethane	5	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
1,1-Dichloroethane	70	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,1-Dichloroethene	4.1	14	<0.5	<4.0	<4.0	<8.0	<0.4	0.2	2.8	<0.1
1,2,4-trichlorobenzene	70	-								
1,2-Dichlorobenzene	3	200	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,2-Dichloroethane	5	5	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	1	<0.1
1,2-Dichloropropane	5	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,3-Dichlorobenzene	630	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
1,4-Dichlorobenzene	1	5	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
2-Hexanone	-	-	<25.0	<200	<200	<400	<20.0	<5	<100	<5
Acetone	3000	-	<50.0	<400	<400	<800	<40.0	<10	<200	<10
Benzene	5	5	***5.8***	2	*2.7	***37.1***	1	1.7	1.9	<0.1
Bromodichloromethane	5	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Bromoform	5	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Bromomethane	10	-	<2.5	<20.0	<20.0	<40.0	<2.0	<0.5	<10.0	<0.5
Carbon Tetrachloride	5	5	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Chlorobenzene	30	80	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Chloroethane	-	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Chloroform	5	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Chloromethane	-	-	<2.5	<20.0	<20.0	<40.0	<2.0	<0.5	<10.0	<0.5
cis-1,2-Dichloroethene	70	-	0.6	<4.0	<4.0	<8.0	8	15.8	***351***	<0.1
cis-1,3-Dichloropropene	-	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Dibromochloromethane	5	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Ethylbenzene	2.4	-	2.4	***54.6***	***54.8***	***24.5***	0.5	1.3	<2.0	<0.1
Ethylene dibromide	1	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Methyl Ethyl Ketone (MEK)	350	-	<25.0	<200	<200	<400	<20.0	<5	<100	<5
Methyl Isobutyl Ketone (MIBK)	350	-	<25.0	<200	<200	<400	<20.0	<5	<100	<5
Methylene Chloride	50	50	<5.0	<40.0	<40.0	<80.0	<4.0	<1	<20.0	<1
Methyl-t-Butyl Ether	700	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.2
Phenol	4200	-								
Styrene	100	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Tetrachloroethene (Perchloroethylene)	5	-	<0.5	<4.0	<4.0	<8.0	<0.4	<0.1	<2.0	<0.1
Toluene	24	-	1	9.5	10.9(8.0)	<16.0	<0.8	0.6	<4.0	0.2
Total Xylenes	300	-	19.2	***350***	***358***	***951.1***	1.3	4.3	<2.0	0.3
trans-1,2-Dichloroethene	100	-	<0.5	<4.0	<4.0	<8.0	<0.4	0.1	6.6	<0.4
trans-1,3-Dichloropropene	-	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.8
Trichloroethene	50	50	<0.5	*2.7	4.3(4.0)	<8.0	<0.4	0.2	***267***	<0.4
Trichlorofluoromethane	-	-	<1.0	<8.0	<8.0	<16.0	<0.8	<0.2	<4.0	<0.8
Vinyl Chloride	1.3	2	<1.0	<8.0	<8.0	<16.0	***26.8***	***51.7***	***108***	<0.2

Notes:
All units in ug/L unless otherwise stated
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.

100	Exceeds either Provincial or Federal Criteria

Table 8c
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Groundwater Quality
PAH Analysis

Parameter	MOEE Table A	CCME	MMM02-2	MMM02-4
Napthalene	21	-	2.74	<0.05
2-Methylnaphthalene	-	-	0.108	<0.05
1-Methylnaphthalene	-	-	0.278	<0.05
Acenaphthylene	310	-	<0.05	<0.05
Acenaphthene	20	-	<0.05	<0.05
Fluorene	280	-	<0.05	<0.05
Phenanthrene	63	-	<0.05	<0.05
Anthracene	12	-	0.012	0.015
Fluoranthene	130	-	<0.01	0.039
Pyrene	40	-	<0.01	0.028
Benzo(a)anthracene	0.2	-	<0.01	<0.01
Chrysene	0.5	-	<0.01	<0.01
Benzo(b)fluoranthene	0.2	-	<0.01	<0.01
Benzo(k)fluoranthene	0.2	-	<0.01	<0.01
Benzo(a)pyrene	0.01	0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	0.2	-	<0.01	<0.01
Dibenzo(a,h)anthracene	0.2	-	<0.01	<0.01
Benzo(ghi)perylene	0.2	-	<0.01	<0.01

Notes:
All units in ug/L unless otherwise stated
* = Detected below EQL but passed compound identification criteria
MOEE Table A: Ontario Ministry of the Environment and Energy, "Guideline for Use at Contaminated Sites in Ontario," February 1997 Table A potable groundwater condition residential/parkland land use, medium and fine textured soil.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999 for residential/parkland uses.
100 Exceeds either Provincial or Federal Criteria

Table 9a
Summary of Analytical Results for Oshawa Harbour
2002 Sampling Program
Surface Water Quality
Inorganic Analysis

Parameter	PWQO	CCME	Montgomery Creek			Harbour		
			MMM02-SS1 (U)	MMM02-SS2 (M)	MMM02-SS3 (D)	MMM02-BS1 (E)	MMM02-BS2 (E)	MMM02-BS3 (M)
			2002	2002	2002	2002	2002	2002
			upgradient	south end of landfill	downgradient	landfill edge		Basin 3 - center
Aluminum	75	5	1840	***401***	***240***	***85***	***34***	***39***
Antimony	20	-	1	0.6	<0.5	<0.5	<0.5	<0.5
Arsenic	5	5	2	<2	<2	<2	<2	<2
Barium	-	-	110	72	49	40	35	34
Beryllium	11	-	<1	<1	<1	<1	1	<1
Bismuth	-	-	<1	<1	<1	<1	<1	<1
Boron	200	-	82	65	46	28	26	27
Bromide	-	-	<500	<500	<500	<500	<500	<500
Cadmium	0.1	0.017	0.7	***0.1***	<0.1	<0.1	<0.1	<0.1
Calcium	-	-	112000	84100	61400	42600	39000	38700
Chloride	-	-	198000	137000	70900	26800	26800	26000
Chromium	100	8.9	18	<5	<5	<5	<5	<5
Cobalt	0.6	-	1.2	0.3	0.2	0.1	<0.1	<0.1
Copper	1	2	24.3	***5.8***	***4.8***	***4.9***	***5.3***	***3.8***
Fluoride	-	-	<100	<100	<100	<100	<100	<100
Iron	300	300	3340	***810***	***430***	120	60	70
Lead	3	1	38.4	***9.2***	***5.9***	***3***	***1.4***	***1.3***
Magnesium	-	-	17600	14400	11500	10000	9890	9720
Manganese	-	-	385	229	112	19	13	14
Molybdenum	40	73	12	9	5	1	1	1
Nitrate	-	-	900	900	300	<200	<200	<200
Nitrite	-	-	<200	<200	<200	<200	<200	<200
Nickel	25	-	16	7	4	2	1	1
Phosphate	-	-	1000	<1000	<1000	<1000	<1000	<1000
Phosphorus	20	20	310	***110***	***80***	<50	<50	<50
Potassium	-	-	4000	2900	2200	1900	1700	1600
Selenium	100	1	<2	<2	<2	<2	<2	<2
Silicon	-	-	7070	3970	2260	1260	1130	1040
Silver	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium	-	-	93200	67800	37800	15100	14600	14300
Strontium	-	-	376	308	231	174	168	167
Sulphates	-	-	39500	30700	26200	24200	24000	24400
Tin	-	-	2	<1	<1	<1	<1	<1
Titanium	-	-	91	19	12	<5	<5	<5
Vanadium	6	6	5.5	2	1.5	0.6	0.6	0.5
Zinc	20	20	246	***49***	***42***	***25***	6	<5

PCBs	0.001	0.001						
TOC	-	-						
conductivity (umhos/cm)	-	-	1052	827	568	356	342	337
pH (unitless)	-	-	7.76	7.68	7.78	7.37	8.16	8.22
Chloride	-	-						
Alkalinity ($CaCO_3$)	-	-						
Hardness ($CaCO_3$)	-	-	352.5	269.3	200.9	147.8	138	136.7

Notes:
All units in ug/L unless otherwise stated
PWQO: Ontario Ministry of the Environment and Energy, "Water Management: Policies, Guidelines, Provincial Water Quality Objectives," February 1999.
CCME: *Canadian Environmental Quality Guidelines*, CCME, 1999
100 Exceeds either Provincial or Federal Criteria

Parameter	WMCO	CORE	MW-05-22S (ft)	MW-05-23S (ft)	MW-05-24S (ft)	MW-05-25S (ft)	MW-05-26S (ft)	MW-05-27S (ft)
			Background Creek			Hotspot		Basin 3 - Center
			2003	2003	2003	2003	2003	2003
Aluminum	50	50	7,470	9,010	3,740	45	50	36
Antimony	6	6	2.3	2	<2	<2	<2	<2
Arsenic	-	-	6	7	<5	<5	<5	<5
Barium	-	-	52	70	15	<5	<5	<5
Beryllium	-	-	0.50	0.60	<0.5	<0.5	<0.5	<0.5
Boron	-	-	61	70	15	<5	<5	<5
Cadmium	5	5	2.5	3	<2	<2	<2	<2
Calcium	-	-	2,020	2,610	1,260	1,160	1,040	1,040
Chromium	100	-	15	18	<5	<5	<5	<5
Cobalt	-	-	5.6	7.1	2.5	<1	<1	<1
Copper	65	-	15	19	5	<5	<5	<5
Iron	300	300	9,210	11,000	4,540	50	50	37
Lead	5	-	3.4	4	2	<2	<2	<2
Magnesium	-	-	1,020	1,260	1,000	1,000	1,000	1,000
Manganese	-	-	210	260	110	2	2	2
Mercury	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	-	-	0.70	0.80	0.30	<0.2	<0.2	<0.2
Nickel	100	-	8	10	3	<2	<2	<2
Potassium	-	-	1,000	1,200	1,000	1,000	1,000	1,000
Selenium	10	50	5.6	7	<5	<5	<5	<5
Silver	-	-	<100	<100	<100	<100	<100	<100
Sodium	50	-	1,000	1,000	1,000	1,000	1,000	1,000
Thallium	-	-	<2	<2	<2	<2	<2	<2
Vanadium	50	5	7.8	9	<5	<5	<5	<5
Zinc	300	300	37	46	11	<5	<5	<5

Table 10
Evaluation of Preferred Alternative

	Feasibility	Ability to Minimise Environmental Effects							Public Accept-ability	Regulatory Accept-ability	Long term maintenance	Relative Cost	Comments
		Minimise potential for leachate generation	Minimise potential for migration of leachate into Montgomery Creek	Minimise potential for migration of leachate into Harbour	Minimise waste exposure during a significant storm event.	Minimises potential for public contact with waste	Minimise exposure to workers and public during construction	Minimise traffic Impacts during construction					
Complete Dumpsite Removal	**May not be feasible**	**Meets objective**	**Meets objective**	**Meets objective**	**Meets objective**	**Meets objective**	May not meet objective	May not meet objective	**High**	Moderate, regulators generally prefer onsite manage-ment, if possible	**No long term maintenance requirements**	**High i.e.; >$4 million (depending on source of backfill)**	**This option meets most of the objectives, however, it is considered cost prohibitive if other options are available.**
Do Nothing	**Feasible**	Does not meet objective.	Does not meet objective.	Does not meet objective.	Does not meet objective.	Does not meet objective.	**Meets objective**	**Meets objective**	Low	Low	**Minimal long term maintenance requirements**	**Not applicable**	**Not recommended**
Engineering Controls													
Containment System: Grade and cap dumpsite	**Feasible**	**Meets objective. Will reduce infiltration by minimising areas where stormwater will pond. Will form a low permeability barrier to minimise infiltration.**	**Will assist in meeting objective. Reduces mounding (if present) within waste, therefore reducing driving force. However, may result in less dilution, which may make existing leachate more heavily contaminated**	**Will assist in meeting objective Reduces mounding (if present) within waste, therefore reducing driving force. However, may result in less dilution, which may make existing leachate more heavily contaminated**	**May assist in meeting Objective.**	**Meets objective. A barrier is formed which prevents contact with waste.**	**Meets objective**	May not meet objective	**High**	**High**	**Minimal long term maintenance requirements**	**Moderate: i.e.; $200,000 to $300,000**	**Recommended as an integral component of the preferred technology. Will minimise leachate generation and potential for dermal contact. Will assist with other aspects of the project.**

Table 10
Evaluation of Preferred Alternative

	Feasibility	Ability to Minimise Environmental Effects							Public Accept-ability	Regulatory Accept-ability	Long term maintenance	Relative Cost	Comments
		Minimise potential for leachate generation	**Minimise potential for migration of leachate into Montgomery Creek**	**Minimise potential for migration of leachate into Harbour**	**Minimise waste exposure during a significant storm event.**	**Minimises potential for public contact with waste**	**Minimise exposure to workers and public during construction**	**Minimise traffic Impacts during construction**					
Containment System: Install groundwater interceptor along Montgomery Creek	**Feasible**	Will not assist in meeting objective	**Meets objective**	Will not assist in meeting objective	May assist in meeting objective	Will not assist in meeting objective	**Meets objective**	**Meets objective**	**High**	**High**	Substantial long term maintenance requirements	**Moderate: i.e.; $100,000 to $500,000**	**Recommended as an integral component of the preferred technology.** **Will reduce impacts to Montgomery Creek.**
Containment System: Install groundwater interceptor along north edge of Basin 3	**Feasible**	Will not assist in meeting objective.	Will not assist in meeting objective.	**Likely meets objective, but without the presence of a buffer, may be difficult to monitor and evaluate.**	Will not assist in meeting objective.	Will not assist in meeting objective.	**Meets objective**	**Meets objective**	**High**	**High**	Substantial long term maintenance requirements	Low i.e.; <$300,000	Could be used in the preferred technology, however, not currently recommended.
Create Buffer: Partial filling of Basin 3	**Feasible**	Will not assist in meeting objective.	Will not assist in meeting objective, may result in more leachate flow to Montgomery Creek, because flow which previously went to Harbour is now being redirected.	**Will assist in meeting objective.** **But will not eliminate leachate movement to harbour.**	**Will assist in meeting objective.**	Will not assist in meeting objective.	**Meets objective**	May not meet objective	Low	May be low	**Low long term maintenance requirements**	Low to moderate: i.e., <$300,000	Could be used in the preferred technology, however, not currently recommended.

Table 10
Evaluation of Preferred Alternative

	Feasibility	Ability to Minimise Environmental Effects							Public Accept-ability	Regulatory Accept-ability	Long term maintenance	Relative Cost	Comments
		Minimise potential for leachate generation	**Minimise potential for migration of leachate into Montgomery Creek**	**Minimise potential for migration of leachate into Harbour**	**Minimise waste exposure during a significant storm event.**	**Minimises potential for public contact with waste**	**Minimise exposure to workers and public during construction**	**Minimise traffic Impacts during construction**					
Create buffer: Partial filling of Basin 3 with groundwater interceptor between dumpsite and remainder of Basin 3	**Feasible**	Will not assist in meeting objective.	Will not assist in meeting objective, see above	**Meets objective**	**Will assist in meeting objective.**	Will not assist in meeting objective.	**Meets objective**	May not meet objective	Low	May be low	Substantial long term maintenance requirements	Moderate i.e., <$500,000	Could be used in the preferred technology, however, not currently recommended.
Create Buffer: Complete filling of Basin 3	**Feasible**	Will not assist in meeting objective.	Will not assist in meeting objective, see above.	**Meets objective**	**Will assist in meeting objective.**	Will not assist in meeting objective.	**Meets objective**	May not meet objective	Very low	May be low	**Low long term maintenance requirements**	**Moderate i.e.; <$300,000**	Recommended as a cost-effective component of the preferred technology. Will minimise potential for impacts to harbour.
Create Buffer: Complete filling of Basin 2 and 3	**Feasible**	Will not assist in meeting objective.	Will not assist in meeting objective, see above.	**Meets objective, likely slightly more effective than infilling Basin 3 alone.**	**Will assist in meeting objective.**	Will not assist in meeting objective	**Meets objective**	May not meet objective	Very low	May be low	**Low long term maintenance requirements**	**Moderate to High i.e.; <$750,000**	This is an effective option, however, it does not significantly lessen the potential impacts over just filling basin 3 and the impacts to the traffic are greater. Will minimise potential for impacts to harbour.

Table 10
Evaluation of Preferred Alternative

	Feasibility	Ability to Minimise Environmental Effects							Public Accept-ability	Regulatory Accept-ability	Long term maintenance	Relative Cost	Comments
		Minimise potential for leachate generation	**Minimise potential for migration of leachate into Montgomery Creek**	**Minimise potential for migration of leachate into Harbour**	**Minimise waste exposure during a significant storm event.**	**Minimises potential for public contact with waste**	**Minimise exposure to workers and public during construction**	**Minimise traffic impacts during construction**					
Create Buffer: Relocate Montgomery Creek	Feasible, but difficult to implement	Will not assist in meeting objective	Will reduce impacts to Creek, however, there is not enough physical space to provide enough buffer to significantly reduce impacts to the Creek.	Will not assist in meeting objective	May assist in meeting objective	Will not assist in meeting objective	**Meets objective**	**Meets objective**	Likely low	Low	**Low long term maintenance requirements**	High i.e., >$500,000	Not recommended. Regulatory acceptability and public acceptability are low. Would not meet any objectives.
Install armour stone, or storm protection along banks of Montgomery Creek	**Feasible**	Will not assist in meeting objective	**Will assist** **Will minimise erosion that may reduce exposure of waste to creek.**	Will not assist in meeting objective	**Meets objective**	Will not assist in meeting objective	**Meets objective**	**Meets objective**	Moderate	**High**	**Low long term maintenance requirements**	**Low i.e.; $300,000**	Recommended as an integral component of the preferred technology. Will reduce potential for waste exposure due to storm event.
Isolated Hot Spot Removal	May not be feasible	May assist in meeting objective, by reducing amount of waste which can contact storm or groundwater.	**Will assist** **Will result in less leachate or lower concentration of contam. in leachate.**	Will not assist in meeting objective.	**Will assist**	Will not assist in meeting objective	May not meet objective	May not meet objective.	**Low to moderate**	**High**	**Low long term maintenance requirements**	Moderate to High $400,000 to $4M	Not recommended, may not be feasible.
Land Use Planning	**Feasible**	May assist in meeting objective in minimising infiltration, if land features or building can be designed or located in a way to minimise infiltration in certain areas.	Will not assist in meeting objective	Will not assist in meeting objective.	May assist in meeting objective	**Meets objective**	**Meets objective**	**Meets objective**	Moderate	**High**	Moderate	**Low i.e., <$100,000**	Recommended as an integral component of the preferred technology. Will minimise potential for dermal contact of wastes, and may assist with other aspects.

APPENDIX A

DESCRIPTION OF

SUBSURFACE INVESTIGATION

APPENDIX A

Description of the Subsurface Investigation

Drilling and Monitoring Well Installation

On June 26, 2002, six boreholes were advanced by GeoEnvironmental Drilling Limited at the Site using a CME 75 truck mounted drill rig equipped with hollow stem augers. Soil samples were collected from each borehole at depth intervals of 0.75 m using a 0.6 m standard split spoon sampler driven by a standard 63.5 kg (140 lb.) hammer. Augers and split spoon samplers were cleaned between samples and borehole locations. The soil cuttings that appeared to be impacted were placed in a 205L drum for subsequent testing and disposal. The boreholes were advanced to a maximum depth of 5.2 m below existing grade. Monitoring wells were installed during the drilling program in all six boreholes. The monitoring wells ranged from three to five meters in length and consisted of 50-mm diameter PVC pipe with 10-slot PVC screen. The annulus around the screened portion of each well was backfilled with silica sand to approximately 0.3 meters above the screen. An approximately 0.60 meters thick bentonite seal was placed above the sand pack. Monitoring wells were completed approximately 0.70 meters above grade with steel casings and lockable caps.

Well elevations were surveyed relative to a local datum so that groundwater flow direction could be assessed, and later adjusted to known elevation. Borehole locations are shown on Figure 2 and logs and construction details are presented in Appendix B.

Soil and Water Sampling

Soil Sampling

Soils were logged in the field noting soil type and texture, structure, colour, moisture content, staining and odour. The split spoon samplers were cleaned between samples and borehole locations. Soil samples were collected in plastic bags and headspace vapour concentrations were measured using a Photoionization Detector (PID).

The samples with the highest vapour reading from each borehole were jarred and placed in a sample cooler to minimise volatilisation of contaminants in the soil pending laboratory analysis. Ten soil samples were analysed for metals and total petroleum hydrocarbons and PAHs.

On July 2, 2002, two test pits were advanced west of the roadway along Basin 3 with a rubber tire excavator to a depth of 1.8 meters. Soils were logged in the field noting soil type and texture, structure, colour, moisture content, staining and odour. One soil sample from each test pit was jarred and placed in a sample cooler pending laboratory analysis for metals.

Groundwater Sampling

On July 2, the six monitoring wells were purged of three volumes of standing water as per

sampling protocols recommended by the MOE. Water levels were obtained prior to well development using a Solinst 100 Water Level Tape. Vapour concentrations were also measured using the PID in the headspace of the monitoring wells immediately after the cap had been removed. The Water Level Tape was cleaned between wells in a phosphate-free detergent/water wash and a water rinse.

Purging and sampling was conducted using clean dedicated Waterra tubing. The sample preservation protocols recommended by the laboratory were followed. Six groundwater samples were submitted for analysis of volatile organic compounds (VOCs), general metals, PCBs and PAHs.

Surface Water Sampling

On July 2, six surface water samples were collected from the Montgomery Creek and Basin 3. Analysis included volatile organic compounds (VOCs) and general metals. During sample collection pH, temperature and electrical conductivity data was obtained.

All samples were stored on ice and transported to PSC Laboratory for analysis. The parameters chosen for analysis were selected based on compounds likely to be associated with the landfill.

APPENDIX B

BOREHOLE AND TESTPIT LOGS

Log of Borehole MMM02-3

Project No: 14-02074-01-EM1

Project: Oshawa Harbour

Client: Oshawa Harbour Commission

Location:

Enclosure:

Logged By: S. Bridle

SUBSURFACE PROFILE					SAMPLE					
Depth (ft / m)	Symbol	Description	Depth/Elev	Well Data	Number	Type	N Value	Recovery	Vapour ppm	Remarks
0 / 0		Ground Surface	0							
1		***SILTY SAND FILL*** redish brown silt, sand and fill with ash, damp.	76.61		SS1	SS	50	21%	8.7	
2			0.76							
3 / 1		***SAND FILL*** dark brown/black sand fill with stone and glass debris.	75.85		SS2	SS	21	29%	7.1	
4										
5					SS3	SS	14	0%		Water Level recorded on July 2, 2002
6 / 2										
7					SS4	SS	7	0%		
8										
9			3.04							
10 / 3		***CLAY*** grey clay, damp.	73.57		SS5	SS	9	29%	8.5	
11										Well Vapour Conc. 145 ppm recorded on July 2, 2002
12										
13 / 4					SS6	SS	15	38%	6.1	
14			4.4							
15		End of Borehole	72.21							
16 / 5										
17										
18										
19										
20 / 6										
21										

Drilled By: Geo-Environmental Drilling Inc

Drill Method: Auger

Drill Date: June 26, 2002

MARSHALL MACKLIN MONAGHAN
80 Commerce Valley Drive East
Thornhill, Ontario L3T 7N4
Borehole Log is for Environmental Purposes Only

Hole Size: 0.15

Datum:

Sheet: 1 of 1

Log of Borehole MMM02-4

Project No: 14-02074-01-EM1

Project: Oshawa Harbour

Client: Oshawa Harbour Commission

Location:

Enclosure:

Logged By: S. Bridle

SUBSURFACE PROFILE					SAMPLE					
Depth (ft / m)	Symbol	Description	Depth/Elev	Well Data	Number	Type	N Value	Recovery	Vapour ppm	Remarks
0 / 0		Ground Surface	0							
0–2 / 0–1		***FILL with SILT,ASH and CINDERS*** red brown sandy silt with gravel, ash and cinders, damp.	76.65 0.76		SS1	SS	13	42%	0	
3–7 / 1–2		***SILT with FILL*** black fine silt with fill, sand and gravel, damp.	75.89 2.28		SS2	SS	50	12.5%	2.1	
					SS3	SS	12	0%		Water Level recorded on July 2, 2002
8–9 / 2–3		***CLAY and FILL*** grey clay and brick.	74.37 3.04		SS4	SS	3	33%	12.6	
10–13 / 3–4		***CLAY*** grey clay, damp.	73.61 3.97		SS5	SS	5	83%	5.6	Well Vapour conc. 44.1 ppm recorded on July 2, 2002
13 / 4		End of Borehole	72.68							
16 / 5										
19–21 / 6										

Drilled By: Geo-Environmental Drilling Inc

Drill Method: Auger

Drill Date: June 26, 2002

MARSHALL MACKLIN MONAGHAN
80 Commerce Valley Drive East
Thornhill, Ontario L3T 7N4
Borehole Log is for Environmental Purposes Only

Hole Size: 0.15

Datum:

Sheet: 1 of 1

Log of Borehole MMM02-5

Project No: 14-02074-01-EM1

Project: Oshawa Harbour

Client: Oshawa Harbour Commission

Location:

Enclosure:

Logged By: S. Bridle

SUBSURFACE PROFILE					SAMPLE					
Depth (ft / m)	Symbol	Description	Depth/Elev	Well Data	Number	Type	N Value	Recovery	Vapour ppm	Remarks
0 / 0		Ground Surface	0							
1		***SAND FILL with ASH and CINDERS*** grey fine sand with ash and cinders, damp	76.64		SS1	SS	13	42%	87	
2			0.76							
3 / 1		***SILTY CLAY FILL*** course sand and silty clay, wet.	75.88		SS2	SS	50	12.5%	32	
4			1.52							
5		***CLAY*** grey and black clay, trace odours, moist.	75.12		SS3	SS	12	100%	12.6	Water Level recorded on July 2, 2002
6 / 2			2.28							
7		***SILTY CLAY*** grey clay, dense, moist.	74.36		SS4	SS	3	33%	4.1	
8										
9										
10 / 3										
11										
12										Well Vapour Conc. 18.2 ppm recorded on July 2, 2002
13 / 4										
14										
15										
16 / 5					SS5	SS	5	83%	5.5	
17			5.16							
18		End of Borehole	71.48							
19										
20 / 6										
21										

Drilled By: Geo-Environmental Drilling Inc

Drill Method: Auger

Drill Date: June 26, 2002

MARSHALL MACKLIN MONAGHAN
80 Commerce Valley Drive East
Thornhill, Ontario L3T 7N4
Borehole Log is for Environmental Purposes Only

Hole Size: 0.15

Datum:

Sheet: 1 of 1

Log of Borehole MMM02-6

Project No: 14-02074-01-EM1

Project: Oshawa Harbour

Client: Oshawa Harbour Commission

Location:

Enclosure:

Logged By: S. Bridle

SUBSURFACE PROFILE					SAMPLE					
Depth (ft / m)	Symbol	Description	Depth/Elev	Well Data	Number	Type	N Value	Recovery	Vapour ppm	Remarks
0 / 0		Ground Surface	0							
1		***SILTY SAND FILL*** Light grey fine silty sand fill with stone, dry	77.75 / 0.76		SS1	SS	12	50%	6.7	
2 / 3 / 1		***SILT*** greyish brown silt with red oxidation staining, damp.	76.99 / 1.52		SS2	SS	20	50%	2.4	
4 / 5 / 6 / 2		***SILT*** dark grey silt with fine sand, damp.	76.23 / 2.28		SS3	SS	12	63%	1.2	Water Level recorded on July 2, 2002
7 / 8 / 9 / 10 / 3		***CLAYEY SILT*** dark grey clayey silt, moist.	75.47 / 4.62		SS4	SS	22	32%	0	Well Vapour conc. 0 ppm recorded on July 2, 2002
11 / 12 / 13 / 4 / 14 / 15		***CLAY*** light grey till, damp.	73.13 / 5.2		SS6	SS	12	92%	0	
16 / 5 / 17 / 18 / 19 / 6 / 20 / 21		End of Borehole	72.55							

Drilled By: Geo-Environmental Drilling Inc

Drill Method: Auger

Drill Date: June 26, 2002

MARSHALL MACKLIN MONAGHAN
80 Commerce Valley Drive East
Thornhill, Ontario L3T 7N4
Borehole Log is for Environmental Purposes Only

Hole Size: 0.15

Datum:

Sheet: 1 of 1

Testpit Logs

Testpit 1

Depth	Soil Description
0-0.5 m	Sand fill
0.5 - 1.0 m	Sand fill with ash and cinders, some brick, some cobbles
1.0 – 1.8 m	Sand fill with large cobbles
1.8 – 2.0 m	Native – silty clay

Testpit 2

Depth	Soil Description
0-0.3 m	Sand fill
0.3 – 0.6 m	Sand fill with ash and cinders
0.6 – 1.0 m	Sand fill
1.0 – 1.3 m	Native – silty clay

APPENDIX C
CERTIFICATES OF ANALYSIS

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

TCLP Leach

Sample Id	Hg ICP/MS mg/L	As ICP/MS mg/L	Se ICP/MS mg/L	B ICP/MS mg/L	Ba ICP/MS mg/L	Cd ICP/MS mg/L	Cr ICP/MS mg/L	Pb ICP/MS mg/L
CUTTINGS	<0.01	<0.2	<0.1	0.4	3.7	0.22	0.1	22.7
Blank	<0.01	<0.2	<0.1	<0.1	<0.2	<0.05	<0.1	<0.1
QC Standard (found)	0.16	1.0	0.9	0.5	1.0	0.50	0.5	0.5
QC Standard (expected)	0.20	1.0	1.0	0.5	1.0	0.50	0.5	0.5
Repeat CUTTINGS	<0.01	<0.2	<0.1	0.4	3.6	0.21	<0.1	23.4

Sample Id	Ag ICP/MS mg/L	U ICP/MS mg/L
CUTTINGS	<0.01	<0.01
Blank	<0.01	<0.01
QC Standard (found)	0.04	0.05
QC Standard (expected)	0.03	0.04
Repeat CUTTINGS	<0.01	<0.01

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

Parameter			MMM02-01 SS2 soil	MMM02-02 SS2 soil	MMM02-03 SS1 soil	MMM02-03 SS2 soil	MMM02-04 SS4 soil	MMM02-04 SS1 soil	MMM02-05 SS2 soil
Antimony	SW 6020 mod.	ug/g	185.	402.	700.	756.	36.0	43.1	52.9
Arsenic	SW 6020 mod.	ug/g	42.0	40.3	35.9	40.3	7.7	33.0	7.8
Barium	SW 6020 mod.	ug/g	705	324	660	707	1440	1200	147
Beryllium	SW 6020 mod.	ug/g	0.6	0.3	0.6	0.7	0.9	0.9	0.5
Cadmium	SW 6020 mod.	ug/g	99.6	66.0	153.	69.1	4.9	28.1	15.3
Chromium	SW 6020 mod.	ug/g	115	1140	524	694	601	81	73
Chromium (6+)	SW 7196	ug/g	<1	<1	<1	<1	2	<1	<1
Cobalt	SW 6020 mod.	ug/g	19	75	33	117	34	13	13
Copper	SW 6020 mod.	ug/g	422	3240	1430	2750	147	367	298
Lead	SW 6020 mod.	ug/g	6040	18300	13000	10200	2140	1740	1390
Mercury	SW 7470	ug/g	0.28	0.24	3.63	0.67	0.10	0.64	0.29
Molybdenum	SW 6020 mod.	ug/g	18	27	9	41	<3	7	4
Nickel	SW 6020 mod.	ug/g	355	404	526	286	43	156	319
Selenium	SW 7741	ug/g	6.5	1.1	3.1	2.4	0.4	3.3	1.5
Silver	SW 6020 mod.	ug/g	3	4	4	4	<1	<1	<1
Vanadium	SW 6020 mod.	ug/g	32	21	34	41	56	28	32
Zinc	SW 6020 mod.	ug/g	34400	12100	7020	10600	1820	1590	1630
Boron (HWS)	SW 6010 mod.	ug/g	1.5	1.5	1.3	2.3	0.9	0.6	4.4
Thallium	SW 6020 mod.	ug/g	0.24	0.36	0.26	0.33	0.40	0.46	0.16

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Status: Final

Job: 2256244

Parameter			MMM02-06 SS1 soil	Blank	Standard (found)	Standard (expected)	Repeat MMM02-01 SS2
Antimony	SW 6020 mod.	ug/g	0.2	<0.2	0.8	0.7	160.
Arsenic	SW 6020 mod.	ug/g	1.2	<0.2	24.9	23.6	39.9
Barium	SW 6020 mod.	ug/g	38	<5	173	174	797
Beryllium	SW 6020 mod.	ug/g	<0.2	<0.2	0.7	0.6	0.7
Cadmium	SW 6020 mod.	ug/g	<0.5	<0.5	0.6	0.5	101.
Chromium	SW 6020 mod.	ug/g	8	<1	51	51	117
Chromium (6+)	SW 7196	ug/g	<1	<1	<1	3	3
Cobalt	SW 6020 mod.	ug/g	3	<2	28	28	35
Copper	SW 6020 mod.	ug/g	6	<1	32	33	453
Lead	SW 6020 mod.	ug/g	8	<5	25	24	6360
Mercury	SW 7470	ug/g	0.02	<0.01	0.31	0.29	0.24
Molybdenum	SW 6020 mod.	ug/g	<3	<3	<3	<3	17
Nickel	SW 6020 mod.	ug/g	7	<2	45	46	456
Selenium	SW 7741	ug/g	<0.2	<0.2	0.5	0.5	7.3
Silver	SW 6020 mod.	ug/g	<1	<1	2	2	3
Vanadium	SW 6020 mod.	ug/g	15	<1	49	51	31
Zinc	SW 6020 mod.	ug/g	36	<5	138	133	36700
Boron (HWS)	SW 6010 mod.	ug/g	<0.2	<0.2	1.0	1.0	1.5
Thallium	SW 6020 mod.	ug/g	0.09	<0.05	0.27	0.27	0.24

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Page: 4
Copy: 1 of 2

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: .....

Ralph Siebert, B.Sc.
Section Supervisor, Metals

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

Soil Samples

Sample Id	TPH-Heavy Oil SM 5520F ug/g	TPH-Gas+Diesel Calc. ug/g	TPH-Gas P&T GC/MS ug/g	TPH-Diesel GC/FID ug/g
MMM02-04 SS4	<100	130	13	120
MMM02-05 SS1	400	300	33	260
Blank	<100	<10	<10	<10
QC Standard (found)	96%	---	---	96%
QC Standard (expected)	100%	---	---	100%
Repeat MMM02-04 SS4	---	---	18	---

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

Soil Samples

Sample Id	TPH-Heavy Oils SM 5520F ug/g	TPH-Gas+Diesel Calc. ug/g	TPH-Gas HS-GC/FID ug/g	TPH-Diesel GC/FID ug/g
MMM02-01 SS2	970	230	<10	230
MMM02-01 SS1	<100	<10	<10	<10
MMM02-03 SS5	<100	<10	<10	<10
MMM02-06 SS2	<100	<10	<10	<10
Blank	<100	<10	<10	<10
QC Standard (found)	96%	---	100%	96%
QC Standard (expected)	100%	---	100%	100%

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

Soil Samples

Sample Id	PCB's GC/ECD ug/g	DCBP GC/ECD % Recovery
MMM02-03 SS5	<0.05	101. %
MMM02-03 SS1	<1.00	---
MMM02-04 SS1	0.20	104. %
Blank	<0.05	95.0 %
QC Standard (found)	112. %	92.0 %
QC Standard (expected)	100. %	100. %
Repeat MMM02-03 SS5	<0.05	102. %

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Page: 4
Copy: 1 of 1

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

- DCBP: Decachlorobiphenyl (surrogate standard for PCBs).
- The PCBs detected in sample MMM02-04 SS1 is a mixture of Aroclors 1254 and 1260.
- For the analysis of PCBs, sample MMM02-3 SS1 was diluted by a factor of 20 due to the presence of interfering material. The E.Q.L. was corrected accordingly and no surrogate recovery was reported.
- TPH-Gas represents total purgeable hydrocarbons (less than C10) based on either gasoline calibration using Headspace/GC/FID, or the internal standard method of calibration using Purge & Trap/GC/MS.
- TPH-Diesel represents total extractable hydrocarbons (C10-C24) based on diesel calibration, using GC/FID.
- TPH-Gas+Diesel is the summation of TPH-Gas and TPH-Diesel.
- The TPH-Diesel detected in sample MMM02-04 SS4 is mainly due to a light hydrocarbon contamination eluting in the kerosene range (C8-C12) and an oil contamination ranging from C16 to C32 rather than a true diesel.
- The TPH-Diesel detected in sample MMM02-05 SS1 is mainly due to a light hydrocarbon contamination ranging from C10 to C14 and an oil contamination ranging from C14 to C50 rather than a true diesel.
- The TPH-Diesel detected in sample MMM02-01 SS2 is mainly due to an oil contamination ranging from C14 to C50 rather than a true diesel.

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 27-Jun-2002 13:45
PO #: 624-2002-RM

Job: 2256244

Status: Final

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: .....

Medhat Riskallah, Ph.D., C.Chem.
Manager, Gas Chromatography Section

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256244
Matrix: Soil

VOLATILE ORGANIC COMPOUNDS

Date: 8-Jul-02

Units: micrograms/gram (ug/g) dry weight
( ) = Value in parenthesis indicates EQL for diluted sample

Compound	EQL ug/g	MM02-04-SS4	MM02-04-SS4	MW02-02 SS2	MW02-05 SS1
Chloromethane	1.0	nd	nd	nd(10.0)	nd(8.0)
Vinyl Chloride	0.5	nd	nd	nd(5.0)	nd(4.0)
Bromomethane	1.0	nd	nd	nd(10.0)	nd(8.0)
Chloroethane	0.5	nd	nd	nd(5.0)	nd(4.0)
Trichlorofluoromethane	0.2	nd	nd	nd(2.0)	nd(1.6)
Acetone	10.0	nd	nd	nd(100)	nd(80.0)
1,1-Dichloroethene	0.1	nd	nd	nd(1.0)	nd(0.8)
Dichloromethane (Methylene Chloride)	0.5	nd	nd	nd(5.0)	nd(4.0)
trans-1,2-Dichloroethene	0.1	nd	nd	nd(1.0)	nd(0.8)
Methyl-t-Butyl Ether	0.1	nd	nd	nd(1.0)	nd(0.8)
1,1-Dichloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
Methyl Ethyl Ketone (MEK)	5.0	nd	nd	nd(50.0)	nd(40.0)
cis-1,2-Dichloroethene	0.1	nd	nd	nd(1.0)	nd(0.8)
Chloroform	0.1	nd	nd	nd(1.0)	nd(0.8)
1,2-Dichloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
1,1,1-Trichloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
Carbon Tetrachloride	0.1	nd	nd	nd(1.0)	nd(0.8)
Benzene	0.05	nd	nd	nd(0.5)	nd(0.4)
1,2-Dichloropropane	0.1	nd	nd	nd(1.0)	nd(0.8)
Trichloroethene (Trichloroethylene)	0.1	nd	nd	nd(1.0)	nd(0.8)
Bromodichloromethane	0.1	nd	nd	nd(1.0)	nd(0.8)
cis-1,3-Dichloropropene	0.1	nd	nd	nd(1.0)	nd(0.8)
Methyl Isobutyl Ketone (MIBK)	5.0	nd	nd	nd(50.0)	nd(40.0)
trans-1,3-Dichloropropene	0.1	nd	nd	nd(1.0)	nd(0.8)
1,1,2-Trichloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
Toluene	0.1	0.1	0.1	1.5(1.0)	*0.6(0.8)
2-Hexanone	5.0	nd	nd	nd(50.0)	nd(40.0)
Dibromochloromethane	0.1	nd	nd	nd(1.0)	nd(0.8)
1,2-Dibromoethane (Ethylene dibromide)	0.1	nd	nd	nd(1.0)	nd(0.8)
Tetrachloroethene (Perchloroethylene)	0.1	nd	nd	nd(1.0)	nd(0.8)
1,1,1,2-Tetrachloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
Chlorobenzene	0.1	nd	nd	nd(1.0)	nd(0.8)
Ethylbenzene	0.1	nd	nd	11.1(1.0)	nd(0.8)
m-Xylene & p-Xylene	0.1	*0.1	0.1	51.8(1.0)	nd(0.8)
Bromoform	0.1	nd	nd	nd(1.0)	nd(0.8)
Styrene	0.1	nd	nd	nd(1.0)	nd(0.8)
1,1,2,2-Tetrachloroethane	0.1	nd	nd	nd(1.0)	nd(0.8)
o-Xylene	0.1	nd	nd	21.4(1.0)	nd(0.8)
1,3-Dichlorobenzene	0.1	nd	nd	nd(1.0)	nd(0.8)
1,4-Dichlorobenzene	0.1	nd	nd	nd(1.0)	nd(0.8)
1,2-Dichlorobenzene	0.1	nd	nd	nd(1.0)	nd(0.8)
Surrogate Standard Recoveries	(Control Limits)				
Dibromofluoromethane (70-130%)		108%	104%	105%	105%
Toluene-d8 (70-130%)		95%	95%	98%	97%
4-Bromofluorobenzene (70-130%)		105%	101%	106%	98%

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256244
Matrix: Soil

VOLATILE ORGANIC COMPOUNDS

Date: 8-Jul-02

Units: micrograms/gram (ug/g) dry weight

		Method Blank			Spiked Method Blank			
Compound	EQL ug/g	Result	Upper Limit	Accept	% Recovery	Lower Limit	Upper Limit	Accept
Chloromethane	1.0	nd	1.0	yes	108	60	140	yes
Vinyl Chloride	0.5	nd	0.5	yes	106	60	140	yes
Bromomethane	1.0	nd	1.0	yes	108	60	140	yes
Chloroethane	0.5	nd	0.5	yes	107	60	140	yes
Trichlorofluoromethane	0.2	nd	0.2	yes	105	60	140	yes
Acetone	10.0	nd	10.0	yes	108	60	140	yes
1,1-Dichloroethene	0.1	nd	0.1	yes	105	70	130	yes
Dichloromethane (Methylene Chloride)	0.5	nd	0.5	yes	107	70	130	yes
trans-1,2-Dichloroethene	0.1	nd	0.1	yes	106	70	130	yes
Methyl-t-Butyl Ether	0.1	nd	0.1	yes	108	70	130	yes
1,1-Dichloroethane	0.1	nd	0.1	yes	108	70	130	yes
Methyl Ethyl Ketone (MEK)	5.0	nd	5.0	yes	112	60	140	yes
cis-1,2-Dichloroethene	0.1	nd	0.1	yes	108	70	130	yes
Chloroform	0.1	nd	0.1	yes	108	70	130	yes
1,2-Dichloroethane	0.1	nd	0.1	yes	110	70	130	yes
1,1,1-Trichloroethane	0.1	nd	0.1	yes	106	70	130	yes
Carbon Tetrachloride	0.1	nd	0.1	yes	108	70	130	yes
Benzene	0.05	nd	0.05	yes	107	70	130	yes
1,2-Dichloropropane	0.1	nd	0.1	yes	109	70	130	yes
Trichloroethene (Trichloroethylene)	0.1	nd	0.1	yes	106	70	130	yes
Bromodichloromethane	0.1	nd	0.1	yes	108	70	130	yes
cis-1,3-Dichloropropene	0.1	nd	0.1	yes	112	70	130	yes
Methyl Isobutyl Ketone (MIBK)	5.0	nd	5.0	yes	112	60	140	yes
trans-1,3-Dichloropropene	0.1	nd	0.1	yes	112	70	130	yes
1,1,2-Trichloroethane	0.1	nd	0.1	yes	110	70	130	yes
Toluene	0.1	nd	0.1	yes	107	70	130	yes
2-Hexanone	5.0	nd	5.0	yes	110	60	140	yes
Dibromochloromethane	0.1	nd	0.1	yes	111	70	130	yes
1,2-Dibromoethane (Ethylene dibromide)	0.1	nd	0.1	yes	110	70	130	yes
Tetrachloroethene (Perchloroethylene)	0.1	nd	0.1	yes	109	70	130	yes
1,1,1,2-Tetrachloroethane	0.1	nd	0.1	yes	112	70	130	yes
Chlorobenzene	0.1	nd	0.1	yes	109	70	130	yes
Ethylbenzene	0.1	nd	0.1	yes	111	70	130	yes
m-Xylene & p-Xylene	0.1	nd	0.1	yes	110	70	130	yes
Bromoform	0.1	nd	0.1	yes	110	70	130	yes
Styrene	0.1	nd	0.1	yes	113	70	130	yes
1,1,2,2-Tetrachloroethane	0.1	nd	0.1	yes	109	70	130	yes
o-Xylene	0.1	nd	0.1	yes	110	70	130	yes
1,3-Dichlorobenzene	0.1	nd	0.1	yes	118	70	130	yes
1,4-Dichlorobenzene	0.1	nd	0.1	yes	120	70	130	yes
1,2-Dichlorobenzene	0.1	nd	0.1	yes	118	70	130	yes
Surrogate Standard Recoveries	(Control Limits)							
Dibromofluoromethane		104%	70-130%	yes	99	70	130	yes
Toluene-d8		98%	70-130%	yes	100	70	130	yes
4-Bromofluorobenzene		94%	70-130%	yes	99	70	130	yes

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256244
Matrix: Soil

VOLATILE ORGANIC COMPOUNDS

Date: 8-Jul-02

Legend: EQL = Estimated Quantitation Limit for undiluted samples
nd = Not Detected Above EQL
Dup. = Duplicate
* = Detected below EQL but passed compound identification criteria

Date of sample receipt: June 27, 2002
Date of sample analysis: July 4 - 5, 2002

Analytical Method:

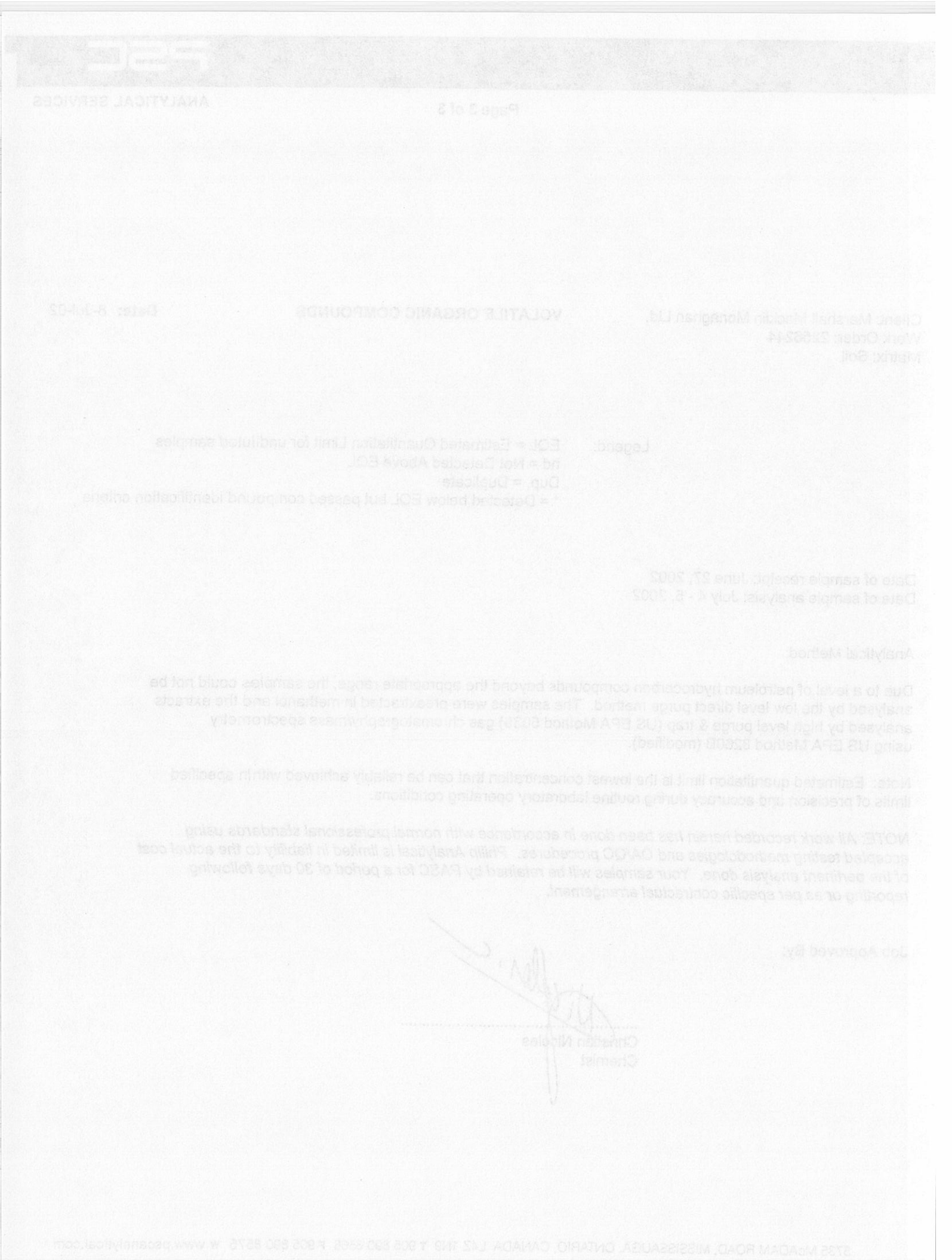
Due to a level of petroleum hydrocarbon compounds beyond the appropriate range, the samples could not be analysed by the low level direct purge method. The samples were preextracted in methanol and the extracts analysed by high level purge & trap (US EPA Method 5035) gas chromatography/mass spectrometry using US EPA Method 8260B (modified).

Note: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangement.

Job Approved By:

Christian Nicolas
Chemist



Client: Marshall Macklin Monaghan Ltd.
Work Order Number: 2256244B
Matrix: Soil

Polynuclear Aromatic Hydrocarbons (PAH's)

Units: Micrograms/gram (µg/g) dry weight

Date: 08-Jul-02

Compound	**EQL µg/g**	MMM02-03 SS1 DF=4	**EQL µg/g**	MMM02-03 SS5	**EQL µg/g**	MMM02-04 SS1 DF=4
Naphthalene	0.20	0.22	0.05	nd	0.20	nd
2-Methylnaphthalene	0.20	nd	0.05	nd	0.20	nd
1-Methylnaphthalene	0.20	nd	0.05	nd	0.20	nd
Acenaphthylene	0.20	nd	0.05	nd	0.20	nd
Acenaphthene	0.20	nd	0.05	nd	0.20	nd
Fluorene	0.20	nd	0.05	nd	0.20	nd
Phenanthrene	0.20	0.53	0.05	nd	0.20	0.22
Anthracene	0.20	*0.11	0.05	nd	0.20	nd
Fluoranthene	0.20	0.83	0.05	nd	0.20	0.34
Pyrene	0.20	0.76	0.05	nd	0.20	0.28
Benzo(a)anthracene	0.20	0.39	0.05	nd	0.20	*0.16
Chrysene	0.20	0.49	0.05	nd	0.20	*0.15
Benzo(b)fluoranthene	0.20	0.66	0.05	nd	0.20	0.20
Benzo(k)fluoranthene	0.20	0.22	0.05	nd	0.20	nd
Benzo(a)pyrene	0.20	0.37	0.05	nd	0.20	*0.15
Indeno(1,2,3-cd)pyrene	0.20	0.37	0.05	nd	0.20	*0.13
Dibenzo(a,h)anthracene	0.20	*0.11	0.05	nd	0.20	nd
Benzo(ghi)perylene	0.20	0.38	0.05	nd	0.20	*0.11
Surrogate Standard Recoveries (Control Limits)						
Acenaphthene-d10 (19-121%)		86%		77%		88%
Anthracene-d10 (27-126%)		96%		84%		96%
Benzo(a)pyrene-d12 (44-136%)		88%		86%		90%

Client: Marshall Macklin Monaghan Ltd.
Work Order Number: 2256244B
Matrix: Soil

Polynuclear Aromatic Hydrocarbons (PAH's)

Units: Micrograms/gram (µg/g) dry weight

Date: 08-Jul-02

		Method Blank			Spiked Method Blank			
Compound	**EQL µg/g**	**Result**	**Upper Limit**	**Accept**	**% Recovery**	**Lower Limit**	**Upper Limit**	**Accept**
Naphthalene	0.05	nd	0.05	yes	89	42	107	yes
2-Methylnaphthalene	0.05	nd	0.05	yes	97	44	114	yes
1-Methylnaphthalene	0.05	nd	0.05	yes	97	46	119	yes
Acenaphthylene	0.05	nd	0.05	yes	98	39	114	yes
Acenaphthene	0.05	nd	0.05	yes	96	34	113	yes
Fluorene	0.05	nd	0.05	yes	100	36	120	yes
Phenanthrene	0.05	nd	0.05	yes	95	40	120	yes
Anthracene	0.05	nd	0.05	yes	97	42	124	yes
Fluoranthene	0.05	nd	0.05	yes	93	47	126	yes
Pyrene	0.05	nd	0.05	yes	94	46	125	yes
Benzo(a)anthracene	0.05	nd	0.05	yes	94	45	142	yes
Chrysene	0.05	nd	0.05	yes	95	46	148	yes
Benzo(b)fluoranthene	0.05	nd	0.05	yes	95	40	135	yes
Benzo(k)fluoranthene	0.05	nd	0.05	yes	93	40	129	yes
Benzo(a)pyrene	0.05	nd	0.05	yes	91	41	128	yes
Indeno(1,2,3-cd)pyrene	0.05	nd	0.05	yes	102	35	132	yes
Dibenzo(a,h)anthracene	0.05	nd	0.05	yes	106	34	137	yes
Benzo(ghi)perylene	0.05	nd	0.05	yes	107	38	130	yes
Surrogate Standard Recoveries								
Acenaphthene-d10		79%			84	19	121	yes
Anthracene-d10		85%			90	27	126	yes
Benzo(a)pyrene-d12		85%			89	44	136	yes

Client: Marshall Macklin Monaghan Ltd. **Polynuclear Aromatic Hydrocarbons (PAH's)**
Work Order Number: 2256244B
Matrix: Soil

Date: 08-Jul-02

Legend: EQL = Estimated Quantitation Limit
nd = Not detected above EQL
DF = Dilution Factor
* = Detected below EQL but passed compound identification criteria

Date received: June 27, 2002
Date extracted: July 5, 2002
Date analysed: July 5-6, 2002

ANALYTICAL METHOD:

The soil samples (10 grams wet weight) were mixed with sodium sulfate and extracted with a 1:1 mixture of acetone:dichloromethane. The extracts were cleaned up using alumina column chromatography. Analysis was performed by gas chromatography/mass spectrometry using U.S. EPA Method 8270C (modified).

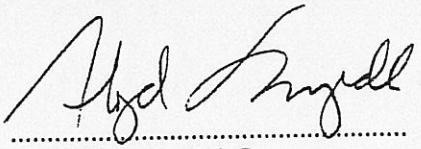
REPORT DISCUSSION:

Some of the samples were run at a dilution factor of 4 due to elevated levels of nontarget compounds present. Excessive levels of nontarget compounds may interfere with the proper quantitation of the sample and may also cause contamination of the analytical equipment if run undiluted. The quantitation limits for these samples are higher than the EQL's for undiluted samples as indicated above.

Note: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangement.

JOB APPROVED BY:



Floyd Mayede, B.A.Sc.
Supervisor/GC-MS Semivolatiles Group

Client: Marshall Macklin Monaghan Limited
Work Order Number: 2256244B
Matrix: TCLP Leach

Semivolatile Organic Compounds (TCLP)

Date: 08-Jul-02

Compound	**EQL µg/L**	Cuttings
2,4-Dichlorophenol	2.0	nd
2,4,5-Trichlorophenol	2.0	nd
2,4,6-Trichlorophenol	2.0	nd
2,3,4,5-Tetrachlorophenol & 2,3,4,6-Tetrachlorophenol	2.0	nd
Pentachlorophenol	8.0	nd
Pyridine	20.0	nd
o-Cresol	2.0	nd
m-Cresol & p-Cresol	2.0	nd
2,4-Dinitrotoluene	2.0	nd
Nitrobenzene	2.0	nd
Benzo(a)pyrene	0.8	nd

Surrogate Standard Recoveries (Control Limits)

Nitrobenzene-d5 (18%-100%)	50%
2-Fluorobiphenyl (17%-106%)	50%
Terphenyl-d14 (32%-132%)	58%
2-Fluorophenol (10%-85%)	30%
Phenol-d5 (10%-88%)	21%
2,4,6-Tribromophenol (20%-122%)	63%

Client: Marshall Macklin Monaghan Limited
Work Order Number: 2256244B
Matrix: TCLP Leach

Semivolatile Organic Compounds (TCLP)

Date: 08-Jul-02

Compound	EQL µg/L	Method Blank Result	Method Blank Upper Limit	Method Blank Accept	Spiked Method Blank % Recovery	Spiked Method Blank Lower Limit	Spiked Method Blank Upper Limit	Spiked Method Blank Accept
2,4-Dichlorophenol	2.0	nd	2.0	yes	67	47	111	yes
2,4,5-Trichlorophenol	2.0	nd	2.0	yes	68	51	110	yes
2,4,6-Trichlorophenol	2.0	nd	2.0	yes	65	50	110	yes
2,3,4,5-Tetrachlorophenol & 2,3,4,6-Tetrachlorophenol	2.0	nd	2.0	yes	81	54	114	yes
Pentachlorophenol	8.0	nd	8.0	yes	81	43	118	yes
Pyridine	20.0	nd	20.0	yes	43	5	110	yes
o-Cresol	2.0	nd	2.0	yes	51	42	100	yes
m-Cresol & p-Cresol	2.0	nd	2.0	yes	48	42	99	yes
2,4-Dinitrotoluene	2.0	nd	2.0	yes	70	54	118	yes
Nitrobenzene	2.0	nd	2.0	yes	63	38	107	yes
Benzo(a)pyrene	0.8	nd	0.8	yes	76	54	130	yes
Surrogate Standard Recoveries:								
Nitrobenzene-d5		62%	18%-100%	yes	60	18	100	yes
2-Fluorobiphenyl		60%	17%-106%	yes	61	17	106	yes
Terphenyl-d14		66%	32%-132%	yes	71	32	132	yes
2-Fluorophenol		33%	10%-85%	yes	37	10	85	yes
Phenol-d5		22%	10%-88%	yes	27	10	88	yes
2,4,6-Tribromophenol		64%	20%-122%	yes	75	20	122	yes

Client: Marshall Macklin Monaghan Limited
Work Order Number: 2256244B
Matrix: TCLP Leach

Semivolatile Organic Compounds (TCLP)

Date: 08-Jul-02

Legend: EQL = Estimated Quantitation Limit
Units = Micrograms per liter (µg/L)
nd = Not detected above EQL

Date received: June 27, 2002
Date TCLP leached: July 3-4, 2002
Date extracted: July 5, 2002
Date analysed: July 6, 2002

Analytical Method:

A portion of the sample was leached as described in US EPA Method 1311 - Toxicity Characteristic Leaching Procedure (TCLP). The TCLP leachate was extracted and analysed by gas chromatography/mass spectrometry using US EPA Method 8270C (modified).

Note: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangement.

Job Approved By:

Kathy Horvat, B.Sc.
Chemist

PSL

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Status: Final

Job: 2256386

Parameter		TEST PIT 1 soil	TEST PIT 2 soil	Blank	Standard (found)	Standard (expected)	Repeat TEST PIT 1
Antimony	SW 6020 mod. ug/g	0.8	<0.2	<0.2	0.7	0.7	0.9
Arsenic	SW 6020 mod. ug/g	2.0	3.0	<0.2	24.7	23.6	2.3
Barium	SW 6020 mod. ug/g	73	138	<5	184	174	76
Beryllium	SW 6020 mod. ug/g	0.4	0.6	<0.2	0.6	0.6	0.3
Cadmium	SW 6020 mod. ug/g	<0.5	<0.5	<0.5	0.6	0.5	<0.5
Chromium	SW 6020 mod. ug/g	17	28	<1	54	51	16
Chromium (6+)	SW 7196 ug/g	<1	<1	<1	3	3	<1
Cobalt	SW 6020 mod. ug/g	5	8	<2	29	28	5
Copper	SW 6020 mod. ug/g	14	19	<1	34	33	13
Lead	SW 6020 mod. ug/g	45	15	<5	25	24	47
Mercury	SW 7470 ug/g	0.02	0.04	<0.01	0.31	0.29	0.02
Molybdenum	SW 6020 mod. ug/g	<3	<3	<3	<3	<3	<3
Nickel	SW 6020 mod. ug/g	12	23	<2	49	46	12
Selenium	SW 6020 mod. ug/g	<0.2	<0.2	<0.2	0.6	0.5	<0.2
Silver	SW 6020 mod. ug/g	<1	<1	<1	1	2	<1
Vanadium	SW 6020 mod. ug/g	22	34	<1	51	51	23
Zinc	SW 6020 mod. ug/g	53	64	<5	139	131	54
Thallium	SW 6020 mod. ug/g	0.08	0.17	<0.05	0.26	0.27	0.09
Boron (HWS)	SW 6010 mod. ug/g	0.6	0.6	<0.2	5.0	5.0	0.6

PSC

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: .....

Ralph Siebert, B.Sc.
Section Supervisor, Metals

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	Ag ICP/MS mg/L	Al ICP/MS mg/L	As ICP/MS mg/L	B ICP/MS mg/L	Ba ICP/MS mg/L	Be ICP/MS mg/L	Bi ICP/MS mg/L	Ca ICP/MS mg/L
MMM02-1	<0.0001	0.007	0.011	0.574	0.953	<0.001	<0.001	133.
MMM02-2	<0.0001	<0.005	0.002	0.351	0.067	<0.001	<0.001	197.
MMM02-3	<0.0001	0.017	<0.002	0.609	0.216	<0.001	<0.001	170.
MMM02-4	<0.0001	0.007	0.002	0.465	0.255	<0.001	<0.001	127.
MMM02-5	<0.0001	0.068	<0.002	0.254	0.044	<0.001	<0.001	192.
MMM02-6	<0.0001	0.008	<0.002	0.029	0.069	<0.001	<0.001	200.
Blank	<0.0001	<0.005	<0.002	<0.005	<0.005	<0.001	<0.001	<0.5
QC Standard (found)	0.0031	0.992	0.053	0.050	0.050	0.051	0.050	5.2
QC Standard (expected)	0.0030	1.00	0.050	0.050	0.050	0.050	0.050	5.0
Repeat MMM02-1	<0.0001	0.006	0.010	0.587	0.975	<0.001	<0.001	132.

PSC

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	Cd ICP/MS mg/L	Co ICP/MS mg/L	Cr ICP/MS mg/L	Cu ICP/MS mg/L	Fe ICP/MS mg/L	K ICP/MS mg/L	Mg ICP/MS mg/L	Mn ICP/MS mg/L
MMM02-1	<0.0001	0.0040	<0.005	0.0015	20.6	10.8	32.5	1.14
MMM02-2	0.0011	0.0342	<0.005	0.0034	19.0	7.4	34.0	4.40
MMM02-3	0.0001	0.0133	<0.005	0.0072	6.07	8.6	23.7	1.58
MMM02-4	<0.0001	0.0018	<0.005	0.0021	2.11	1.9	16.6	2.87
MMM02-5	<0.0001	0.0039	<0.005	0.0036	0.08	3.2	40.1	0.830
MMM02-6	<0.0001	0.0034	<0.005	0.0023	0.03	2.1	22.0	1.89
Blank	<0.0001	<0.0001	<0.005	<0.0005	<0.03	<0.1	<0.05	<0.005
QC Standard (found)	0.0500	0.0485	0.049	0.0506	0.06	1.0	1.05	0.049
QC Standard (expected)	0.0500	0.0500	0.050	0.0500	0.05	1.0	1.00	0.050
Repeat MMM02-1	<0.0001	0.0039	<0.005	0.0015	20.8	10.9	33.2	1.14

PSC

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	Mo ICP/MS mg/L	Na ICP/MS mg/L	Ni ICP/MS mg/L	P ICP/MS mg/L	Pb ICP/MS mg/L	Sb ICP/MS mg/L	Se ICP/MS mg/L	Si ICP/MS mg/L
MMM02-1	0.014	43.2	0.083	0.36	0.0020	0.0041	<0.002	8.99
MMM02-2	0.008	39.3	0.118	<0.05	0.0060	0.0228	<0.002	6.05
MMM02-3	0.011	105.	0.058	<0.05	0.0024	0.0187	<0.002	7.43
MMM02-4	0.001	120.	0.007	0.07	0.0018	0.0048	<0.002	8.18
MMM02-5	0.017	73.7	0.006	<0.05	<0.0005	0.0119	<0.002	9.10
MMM02-6	0.014	108.	0.005	<0.05	0.0008	<0.0005	<0.002	7.71
Blank	<0.001	<0.1	<0.001	<0.05	<0.0005	<0.0005	<0.002	<0.05
QC Standard (found)	0.056	4.6	0.047	0.11	0.0505	0.0500	0.052	0.09
QC Standard (expected)	0.050	5.0	0.050	0.10	0.0500	0.0500	0.050	0.10
Repeat MMM02-1	0.014	43.2	0.084	0.37	0.0019	0.0033	<0.002	9.03

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	Sn ICP/MS mg/L	Sr ICP/MS mg/L	Ti ICP/MS mg/L	V ICP/MS mg/L	Zn ICP/MS mg/L	F- SM 4500F mg/L	Cl- SM 4110B mg/L	NO2-N SM 4110B mg/L
MMM02-1	<0.001	0.669	<0.005	0.0006	0.039	0.3	87.0	<0.2
MMM02-2	<0.001	0.637	<0.005	0.0006	1.11	0.3	83.0	<0.2
MMM02-3	<0.001	0.580	<0.005	0.0006	0.195	0.2	203.	<0.2
MMM02-4	<0.001	0.322	<0.005	0.0010	0.062	0.2	107.	<0.2
MMM02-5	<0.001	0.501	<0.005	0.0009	0.020	<0.1	132.	<0.2
MMM02-6	<0.001	0.464	<0.005	0.0013	0.009	<0.1	188.	<0.2
Blank	<0.001	<0.001	<0.005	<0.0005	<0.005	<0.1	<0.5	<0.2
QC Standard (found)	0.051	0.050	0.048	0.0493	0.051	5.2	20.8	10.1
QC Standard (expected)	0.050	0.050	0.050	0.0500	0.050	5.0	20.0	10.0
Repeat MMM02-1	<0.001	0.676	<0.005	0.0006	0.037	0.3	88.7	<0.2

PSC

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	PO4-3 SM 4110B mg/L	Br- SM 4110B mg/L	NO3-N SM 4110B mg/L	SO4= SM 4110B mg/L	pH SM 4500B pH Units	Alk 8.3 SM 2320B mg CaCO3/L	Alk 4.2 SM 2320B mg CaCO3/L
MMM02-1	<1	<0.5	<0.2	46.1	7.06	<1	437
MMM02-2	<1	<0.5	<0.2	157.	6.91	<1	433
MMM02-3	<1	<0.5	<0.2	95.6	7.09	<1	452
MMM02-4	<1	<0.5	<0.2	16.3	7.29	<1	486
MMM02-5	<1	<0.5	<0.2	188.	7.21	<1	426
MMM02-6	<1	<0.5	<0.2	80.4	7.13	<1	493
Blank	<1	<0.5	<0.2	<0.5	---	<1	<1
QC Standard (found)	49	20.6	10.3	48.8	7.01	<1	254
QC Standard (expected)	50	20.0	10.0	50.0	7.00	<1	250
Repeat MMM02-1	<1	<0.5	<0.2	47.1	7.02	<1	457

PSC

ANALYTICAL SERVICES

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	NH3-N SM 4500H mg/L	DOC SM 5310C mg/L	Th. TDS Calc. mg/L	pHs Calc. pH Units	CAB Calc. %	Hard(Calc) SM 2340B mg CaCO3/L	CO3= Calc. mg/L	HCO3- Calc. mg/L
MMM02-1	10.4	38.5	615	6.72	-0.29	466.6	1	530
MMM02-2	1.48	35.8	778	6.56	-1.41	634.1	1	526
MMM02-3	3.73	37.7	877	6.62	3.86	522.9	1	549
MMM02-4	0.63	15.1	681	6.70	0.05	386.0	1	590
MMM02-5	<0.03	6.0	885	6.59	-0.15	646.2	1	517
MMM02-6	0.05	5.7	897	6.51	0.71	591.0	1	599
Blank	<0.03	<0.2	2	11.61	7.73	1.5	nan	nan
QC Standard (found)	1.43	9.7	234	8.33	81.5	17.4	1	307
QC Standard (expected)	1.50	10.0	232	8.35	81.2	16.6	1	302
Repeat MMM02-1	10.4	40.1	630	6.70	1.43	468.7	1	555

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Ground Water Samples

Sample Id	L.I. Calc. None	A.I. Calc. None	R.S.I. Calc. None	Colour SM 2120B TCU	Turb. SM 2130B NTU	Sp. Cond. SM 2510B umhos/cm
MMM02-1	0.3	12.37	6.4	28	20.0	1094
MMM02-2	0.3	12.35	6.2	12	8.1	1211
MMM02-3	0.5	12.46	6.1	26	23.0	1455
MMM02-4	0.6	12.56	6.1	12	8.9	1213
MMM02-5	0.6	12.65	6.0	20	1.2	1364
MMM02-6	0.6	12.59	5.9	12	2.0	1474
Blank	nan	nan	nan	<3	<0.2	1
QC Standard (found)	-1.3	10.65	9.6	50	18.1	714
QC Standard (expected)	-1.4	10.62	9.7	50	18.0	718
Repeat MMM02-1	0.3	12.35	6.4	---	24.0	1098

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Ag ICP/MS mg/L	Al ICP/MS mg/L	As ICP/MS mg/L	B ICP/MS mg/L	Ba ICP/MS mg/L	Be ICP/MS mg/L
MMM02-SS1 (U)	<0.0001	1.84	0.002	0.082	0.110	<0.001
MMM02-SS2 (M)	<0.0001	0.401	<0.002	0.065	0.072	<0.001
MMM02-SS3 (D)	<0.0001	0.240	<0.002	0.046	0.049	<0.001
MMM02-BS1 (E)	<0.0001	0.085	<0.002	0.028	0.040	<0.001
MMM02-BS2 (E)	<0.0001	0.034	<0.002	0.026	0.035	<0.001
MMM02-BS3 (M)	<0.0001	0.039	<0.002	0.027	0.034	<0.001
Blank	<0.0001	<0.005	<0.002	<0.005	<0.005	<0.001
QC Standard (found)	0.0019	0.969	0.098	0.051	0.100	0.005
QC Standard (expected)	0.0030	1.00	0.100	0.050	0.100	0.005
Repeat MMM02-SS1 (U)	<0.0001	1.79	0.002	0.078	0.109	<0.001

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Bi ICP/MS mg/L	Ca ICP/MS mg/L	Cd ICP/MS mg/L	Co ICP/MS mg/L	Cr ICP/MS mg/L	Cu ICP/MS mg/L
MMM02-SS1 (U)	<0.001	112.	0.0007	0.0012	0.018	0.0243
MMM02-SS2 (M)	<0.001	84.1	0.0001	0.0003	<0.005	0.0058
MMM02-SS3 (D)	<0.001	61.4	<0.0001	0.0002	<0.005	0.0048
MMM02-BS1 (E)	<0.001	42.6	0.0001	0.0001	<0.005	0.0049
MMM02-BS2 (E)	<0.001	39.0	<0.0001	<0.0001	<0.005	0.0053
MMM02-BS3 (M)	<0.001	38.7	<0.0001	<0.0001	<0.005	0.0038
Blank	<0.001	<0.5	<0.0001	<0.0001	<0.005	<0.0005
QC Standard (found)	0.100	5.2	0.0486	0.0486	0.049	0.0497
QC Standard (expected)	0.100	5.0	0.0500	0.0500	0.050	0.0500
Repeat MMM02-SS1 (U)	<0.001	110.	0.0007	0.0012	0.018	0.0248

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Fe ICP/MS mg/L	K ICP/MS mg/L	Mg ICP/MS mg/L	Mn ICP/MS mg/L	Mo ICP/MS mg/L	Na ICP/MS mg/L
MMM02-SS1 (U)	3.34	4.0	17.6	0.385	0.012	93.2
MMM02-SS2 (M)	0.81	2.9	14.4	0.229	0.009	67.8
MMM02-SS3 (D)	0.43	2.2	11.5	0.112	0.005	37.8
MMM02-BS1 (E)	0.12	1.9	10.0	0.019	0.001	15.1
MMM02-BS2 (E)	0.06	1.7	9.89	0.013	0.001	14.6
MMM02-BS3 (M)	0.07	1.6	9.72	0.014	0.001	14.3
Blank	<0.03	<0.1	<0.05	<0.005	<0.001	<0.1
QC Standard (found)	0.99	1.1	1.03	0.049	0.049	5.1
QC Standard (expected)	1.00	1.0	1.00	0.050	0.050	5.0
Repeat MMM02-SS1 (U)	3.26	3.6	16.9	0.374	0.012	89.1

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Ni ICP/MS mg/L	P ICP/MS mg/L	Pb ICP/MS mg/L	Sb ICP/MS mg/L	Se ICP/MS mg/L	Si ICP/MS mg/L
MMM02-SS1 (U)	0.016	0.31	0.0384	0.0010	<0.002	7.07
MMM02-SS2 (M)	0.007	0.11	0.0092	0.0006	<0.002	3.97
MMM02-SS3 (D)	0.004	0.08	0.0059	<0.0005	<0.002	2.26
MMM02-BS1 (E)	0.002	0.05	0.0030	<0.0005	<0.002	1.26
MMM02-BS2 (E)	0.001	<0.05	0.0014	<0.0005	<0.002	1.13
MMM02-BS3 (M)	0.001	<0.05	0.0013	<0.0005	<0.002	1.04
Blank	<0.001	<0.05	<0.0005	<0.0005	<0.002	<0.05
QC Standard (found)	0.047	0.99	0.0500	0.103	0.095	0.95
QC Standard (expected)	0.050	1.00	0.0500	0.100	0.100	1.00
Repeat MMM02-SS1 (U)	0.016	0.31	0.0366	0.0010	<0.002	7.04

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Sn ICP/MS mg/L	Sr ICP/MS mg/L	Ti ICP/MS mg/L	V ICP/MS mg/L	Zn ICP/MS mg/L	F- SM 4500F mg/L
MMM02-SS1 (U)	0.002	0.376	0.091	0.0055	0.246	<0.1
MMM02-SS2 (M)	<0.001	0.308	0.019	0.0020	0.049	<0.1
MMM02-SS3 (D)	<0.001	0.231	0.012	0.0015	0.042	<0.1
MMM02-BS1 (E)	<0.001	0.174	<0.005	0.0006	0.025	<0.1
MMM02-BS2 (E)	<0.001	0.168	<0.005	0.0006	0.006	<0.1
MMM02-BS3 (M)	<0.001	0.167	<0.005	0.0005	<0.005	<0.1
Blank	<0.001	<0.001	<0.005	<0.0005	<0.005	<0.1
QC Standard (found)	0.103	0.048	0.050	0.0494	0.050	9.8
QC Standard (expected)	0.100	0.050	0.050	0.0500	0.050	10.0
Repeat MMM02-SS1 (U)	0.002	0.379	0.097	0.0056	0.249	<0.1

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Cl- SM 4110B mg/L	NO2-N SM 4110B mg/L	PO4-3 SM 4110B mg/L	Br- SM 4110B mg/L	NO3-N SM 4110B mg/L	SO4= SM 4110B mg/L	pH SM 4500B pH Units	Alk 8.3 SM 2320B mg CaCO3/L
MMM02-SS1 (U)	198.	<0.2	1	<0.5	0.9	39.5	7.76	<1
MMM02-SS2 (M)	137.	<0.2	<1	<0.5	0.9	30.7	7.68	<1
MMM02-SS3 (D)	70.9	<0.2	<1	<0.5	0.3	26.2	7.78	<1
MMM02-BS1 (E)	26.8	<0.2	<1	<0.5	<0.2	24.2	7.37	<1
MMM02-BS2 (E)	26.8	<0.2	<1	<0.5	<0.2	24.0	8.16	<1
MMM02-BS3 (M)	26.0	<0.2	<1	<0.5	<0.2	24.4	8.22	<1
Blank	<0.5	<0.2	<1	<0.5	<0.2	<0.5	---	<1
QC Standard (found)	19.2	9.7	51	20.0	10.1	47.7	7.01	---
QC Standard (expected)	20.0	10.0	50	20.0	10.0	50.0	7.00	---
Repeat MMM02-SS1 (U)	201.	<0.2	<1	<0.5	1.2	42.2	7.76	<1

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	Alk 4.2 SM 2320B mg CaCO3/L	NH3-N SM 4500H mg/L	DOC SM 5310C mg/L	Th. TDS Calc. mg/L	pHs Calc. pH Units	CAB Calc. %	Hard(Calc) SM 2340B mg CaCO3/L
MMM02-SS1 (U)	219	0.19	5.5	596	7.09	-1.97	352.5
MMM02-SS2 (M)	185	0.15	3.9	448	7.28	-1.30	269.3
MMM02-SS3 (D)	139	0.11	3.4	294	7.52	-3.53	200.9
MMM02-BS1 (E)	109	0.04	3.2	186	7.77	-3.22	147.8
MMM02-BS2 (E)	104	0.04	1.8	178	7.82	-1.51	138.0
MMM02-BS3 (M)	102	0.03	2.4	176	7.83	-1.72	136.7
Blank	<1	<0.03	<0.2	2	11.61	7.73	1.5
QC Standard (found)	246	1.43	5.3	227	8.35	80.6	17.2
QC Standard (expected)	250	1.50	5.0	232	8.35	81.2	16.6
Repeat MMM02-SS1 (U)	215	0.26	5.8	592	7.11	-0.13	344.7

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Surface Water Samples

Sample Id	CO3= Calc. mg/L	HCO3- Calc. mg/L	L.I. Calc. None	A.I. Calc. None	R.S.I. Calc. None	Colour SM 2120B TCU	Turb. SM 2130B NTU	Sp. Cond. SM 2510B umhos/cm
MMM02-SS1 (U)	1	264	0.7	12.65	6.4	74	0.9	1052
MMM02-SS2 (M)	1	223	0.4	12.38	6.9	20	16.6	827
MMM02-SS3 (D)	1	168	0.3	12.23	7.3	38	10.1	568
MMM02-BS1 (E)	1	130	-0.4	11.58	8.2	20	3.5	356
MMM02-BS2 (E)	1	125	0.3	12.32	7.5	<3	1.9	342
MMM02-BS3 (M)	1	122	0.4	12.36	7.4	<3	2.2	337
Blank	nan	nan	nan	nan	nan	<3	<0.2	1
QC Standard (found)	nan	nan	-1.3	10.64	9.7	50	18.1	714
QC Standard (expected)	nan	nan	-1.4	10.62	9.7	50	18.0	718
Repeat MMM02-SS1 (U)	1	260	0.7	12.63	6.5	---	Insuff.	1053

15-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Received: 3-Jul-2002 16:57

Attn: Steve Bridle
Project:

PO #: 624-2002-RM

Status: Final

Job: 2256386

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: .....

Ralph Siebert, B.Sc.
Section Supervisor, Metals

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256386
Matrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Units: micrograms/liter (ug/L)
( ) = Value in parenthesis indicates EQL for diluted sample

Compound	EQL ug/L	Field Blank	MMM02-1	MMM02-2	MMM02-2 Dup.	MMM02-3
Chloromethane	0.5	nd	nd(2.5)	nd(20.0)	nd(20.0)	nd(40.0)
Vinyl Chloride	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Bromomethane	0.5	nd	nd(2.5)	nd(20.0)	nd(20.0)	nd(40.0)
Chloroethane	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Trichlorofluoromethane	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Acetone	10.0	nd	nd(50.0)	nd(400)	nd(400)	nd(800)
1,1-Dichloroethene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Dichloromethane (Methylene Chloride)	1.0	nd	nd(5.0)	nd(40.0)	nd(40.0)	nd(80.0)
trans-1,2-Dichloroethene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Methyl-t-Butyl Ether	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
1,1-Dichloroethane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Methyl Ethyl Ketone (MEK)	5.0	nd	nd(25.0)	nd(200)	nd(200)	nd(400)
cis-1,2-Dichloroethene	0.1	nd	0.6(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Chloroform	0.1	0.1	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,2-Dichloroethane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,1,1-Trichloroethane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Carbon Tetrachloride	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Benzene	0.1	nd	5.8(0.5)	*2.0(4.0)	*2.7(4.0)	37.1(8.0)
1,2-Dichloropropane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Trichloroethene (Trichloroethylene)	0.1	nd	nd(0.5)	*2.7(4.0)	4.3(4.0)	nd(8.0)
Bromodichloromethane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
cis-1,3-Dichloropropene	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Methyl Isobutyl Ketone (MIBK)	5.0	nd	nd(25.0)	nd(200)	nd(200)	nd(400)
trans-1,3-Dichloropropene	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
1,1,2-Trichloroethane	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Toluene	0.2	nd	1.0(1.0)	9.5(8.0)	10.9(8.0)	nd(16.0)
2-Hexanone	5.0	nd	nd(25.0)	nd(200)	nd(200)	nd(400)
Dibromochloromethane	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
1,2-Dibromoethane (Ethylene dibromide)	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Tetrachloroethene (Perchloroethylene)	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,1,1,2-Tetrachloroethane	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Chlorobenzene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Ethylbenzene	0.1	nd	2.4(0.5)	54.6(4.0)	54.8(4.0)	24.5(8.0)
m-Xylene & p-Xylene	0.1	nd	16.5(0.5)	225(4.0)	230(4.0)	947(8.0)
Bromoform	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
Styrene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,1,2,2-Tetrachloroethane	0.2	nd	nd(1.0)	nd(8.0)	nd(8.0)	nd(16.0)
o-Xylene	0.1	nd	2.7(0.5)	125(4.0)	128(4.0)	*4.1(8.0)
1,3-Dichlorobenzene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,4-Dichlorobenzene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
1,2-Dichlorobenzene	0.1	nd	nd(0.5)	nd(4.0)	nd(4.0)	nd(8.0)
Surrogate Standard Recoveries	(Control Limits)					
Dibromofluoromethane (70-130%)		99%	95%	95%	97%	95%
Toluene-d8 (70-130%)		102%	102%	104%	101%	104%
4-Bromofluorobenzene (70-130%)		97%	100%	100%	98%	100%

lient: Marshall Macklin Monaghan Ltd.
ork Order: 2256386
atrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Units: micrograms/liter (ug/L)
( ) = Value in parenthesis indicates EQL for diluted sample

ompound	EQL ug/L	MMM02-4	MMM02-4 Dup.	MMM02-5	MMM02-6
hloromethane	0.5	nd(2.0)	nd	nd(10.0)	nd
inyl Chloride	0.2	26.8(0.8)	51.7	108(4.0)	nd
romomethane	0.5	nd(2.0)	nd	nd(10.0)	nd
hloroethane	0.2	nd(0.8)	nd	nd(4.0)	nd
richlorofluoromethane	0.2	nd(0.8)	nd	nd(4.0)	nd
cetone	10.0	nd(40.0)	nd	nd(200)	nd
,1-Dichloroethene	0.1	nd(0.4)	0.2	2.8(2.0)	nd
ichloromethane (Methylene Chloride)	1.0	nd(4.0)	nd	nd(20.0)	nd
rans-1,2-Dichloroethene	0.1	nd(0.4)	0.1	6.6(2.0)	nd
ethyl-t-Butyl Ether	0.2	nd(0.8)	nd	nd(4.0)	nd
-Dichloroethane	0.1	nd(0.4)	nd	nd(2.0)	nd
yl Ethyl Ketone (MEK)	5.0	nd(20.0)	nd	nd(100)	nd
s-1,2-Dichloroethene	0.1	8.0(0.4)	15.8	351(2.0)	nd
hloroform	0.1	nd(0.4)	nd	nd(2.0)	nd
,2-Dichloroethane	0.1	nd(0.4)	nd	*1.0(2.0)	nd
,1,1-Trichloroethane	0.1	nd(0.4)	nd	nd(2.0)	nd
arbon Tetrachloride	0.1	nd(0.4)	nd	nd(2.0)	nd
enzene	0.1	1.0(0.4)	1.7	*1.9(2.0)	nd
,2-Dichloropropane	0.1	nd(0.4)	nd	nd(2.0)	nd
richloroethene (Trichloroethylene)	0.1	nd(0.4)	0.2	267(2.0)	nd
romodichloromethane	0.1	nd(0.4)	nd	nd(2.0)	nd
cis-1,3-Dichloropropene	0.2	nd(0.8)	nd	nd(4.0)	nd
Methyl Isobutyl Ketone (MIBK)	5.0	nd(20.0)	nd	nd(100)	nd
trans-1,3-Dichloropropene	0.2	nd(0.8)	nd	nd(4.0)	nd
1,1,2-Trichloroethane	0.2	nd(0.8)	nd	nd(4.0)	nd
Toluene	0.2	nd(0.8)	0.6	nd(4.0)	0.2
2-Hexanone	5.0	nd(20.0)	nd	nd(100)	nd
Dibromochloromethane	0.2	nd(0.8)	nd	nd(4.0)	nd
1,2-Dibromoethane (Ethylene dibromide)	0.2	nd(0.8)	nd	nd(4.0)	nd
Tetrachloroethene (Perchloroethylene)	0.1	nd(0.4)	nd	nd(2.0)	nd
1,1,1,2-Tetrachloroethane	0.1	nd(0.4)	nd	nd(2.0)	nd
Chlorobenzene	0.1	nd(0.4)	nd	nd(2.0)	nd
Ethylbenzene	0.1	0.5(0.4)	1.3	nd(2.0)	nd
m-Xylene & p-Xylene	0.1	1.3(0.4)	3.9	nd(2.0)	0.2
Bromoform	0.2	nd(0.8)	nd	nd(4.0)	nd
Styrene	0.1	nd(0.4)	nd	nd(2.0)	nd
1,1,2,2-Tetrachloroethane	0.2	nd(0.8)	nd	nd(4.0)	nd
o-Xylene	0.1	nd(0.4)	0.4	nd(2.0)	0.1
1,3-Dichlorobenzene	0.1	nd(0.4)	nd	nd(2.0)	nd
1,4-Dichlorobenzene	0.1	nd(0.4)	nd	nd(2.0)	nd
1,2-Dichlorobenzene	0.1	nd(0.4)	nd	nd(2.0)	nd
Surrogate Standard Recoveries	(Control Limits)				
Dibromofluoromethane (70-130%)		95%	101%	94%	96%
Toluene-d8 (70-130%)		103%	98%	103%	101%
4-Bromofluorobenzene (70-130%)		98%	99%	98%	97%

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256386
Matrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Units: micrograms/liter (ug/L)

Compound	EQL ug/L	MMM02-SS1(U)	MMM02-SS2(M)	MMM02-SS3(D)	MMM02-BS1(E)	MMM02-BS2(E)	MMM02-BS3(M)
Chloromethane	0.5	nd	nd	nd	nd	nd	nd
Vinyl Chloride	0.2	nd	nd	nd	nd	nd	nd
Bromomethane	0.5	nd	nd	nd	nd	nd	nd
Chloroethane	0.2	nd	nd	nd	nd	nd	nd
Trichlorofluoromethane	0.2	nd	nd	nd	nd	nd	nd
Acetone	10.0	nd	nd	nd	nd	nd	nd
1,1-Dichloroethene	0.1	nd	nd	nd	nd	nd	nd
Dichloromethane (Methylene Chloride)	1.0	nd	nd	nd	nd	nd	nd
trans-1,2-Dichloroethene	0.1	nd	nd	nd	nd	nd	nd
Methyl-t-Butyl Ether	0.2	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	0.1	nd	nd	nd	nd	nd	nd
Methyl Ethyl Ketone (MEK)	5.0	nd	nd	nd	nd	nd	nd
cis-1,2-Dichloroethene	0.1	nd	nd	nd	nd	nd	nd
Chloroform	0.1	0.1	0.1	nd	nd	nd	nd
1,2-Dichloroethane	0.1	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	0.1	nd	nd	nd	nd	nd	nd
Carbon Tetrachloride	0.1	nd	nd	nd	nd	nd	nd
Benzene	0.1	nd	nd	nd	0.1	0.1	0.1
1,2-Dichloropropane	0.1	nd	nd	nd	nd	nd	nd
Trichloroethene (Trichloroethylene)	0.1	nd	nd	nd	nd	nd	nd
Bromodichloromethane	0.1	nd	nd	nd	nd	nd	nd
cis-1,3-Dichloropropene	0.2	nd	nd	nd	nd	nd	nd
Methyl Isobutyl Ketone (MIBK)	5.0	nd	nd	nd	nd	nd	nd
trans-1,3-Dichloropropene	0.2	nd	nd	nd	nd	nd	nd
1,1,2-Trichloroethane	0.2	nd	nd	nd	nd	nd	nd
Toluene	0.2	nd	nd	nd	0.2	0.2	0.2
2-Hexanone	5.0	nd	nd	nd	nd	nd	nd
Dibromochloromethane	0.2	nd	nd	nd	nd	nd	nd
1,2-Dibromoethane (Ethylene dibromide)	0.2	nd	nd	nd	nd	nd	nd
Tetrachloroethene (Perchloroethylene)	0.1	nd	nd	nd	nd	nd	nd
1,1,1,2-Tetrachloroethane	0.1	nd	nd	nd	nd	nd	nd
Chlorobenzene	0.1	nd	nd	nd	nd	nd	nd
Ethylbenzene	0.1	nd	nd	nd	nd	nd	nd
m-Xylene & p-Xylene	0.1	nd	nd	nd	0.2	0.2	0.2
Bromoform	0.2	nd	nd	nd	nd	nd	nd
Styrene	0.1	nd	nd	nd	nd	nd	nd
1,1,2,2-Tetrachloroethane	0.2	nd	nd	nd	nd	nd	nd
o-Xylene	0.1	nd	nd	nd	0.1	0.1	0.1
1,3-Dichlorobenzene	0.1	nd	nd	nd	nd	nd	nd
1,4-Dichlorobenzene	0.1	nd	nd	nd	nd	nd	nd
1,2-Dichlorobenzene	0.1	nd	nd	nd	nd	nd	nd
Surrogate Standard Recoveries	(Control Limits)						
Dibromofluoromethane (70-130%)		97%	97%	98%	98%	99%	99%
Toluene-d8 (70-130%)		102%	100%	100%	101%	102%	101%
4-Bromofluorobenzene (70-130%)		97%	97%	97%	95%	97%	96%

ANALYTICAL SERVICES

lient: Marshall Macklin Monaghan Ltd.
/ork Order: 2256386
latrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Units: micrograms/liter (ug/L)

		Method Blank			Spiked Method Blank			
Compound	EQL ug/L	Result	Upper Limit	Accept	% Recovery	Lower Limit	Upper Limit	Accept
Chloromethane	0.5	nd	0.5	yes	102	60	140	yes
Vinyl Chloride	0.2	nd	0.2	yes	99	60	140	yes
Bromomethane	0.5	nd	0.5	yes	104	60	140	yes
Chloroethane	0.2	nd	0.2	yes	102	60	140	yes
Trichlorofluoromethane	0.2	nd	0.2	yes	97	60	140	yes
Acetone	10.0	nd	10.0	yes	100	60	140	yes
1,1-Dichloroethene	0.1	nd	0.1	yes	101	70	130	yes
Dichloromethane (Methylene Chloride)	1.0	nd	1.0	yes	100	70	130	yes
trans-1,2-Dichloroethene	0.1	nd	0.1	yes	102	70	130	yes
Methyl-t-Butyl Ether	0.2	nd	0.2	yes	100	70	130	yes
1,1-Dichloroethane	0.1	nd	0.1	yes	102	70	130	yes
Methyl Ethyl Ketone (MEK)	5.0	nd	5.0	yes	100	60	140	yes
cis-1,2-Dichloroethene	0.1	nd	0.1	yes	98	70	130	yes
Chloroform	0.1	nd	0.1	yes	100	70	130	yes
1,2-Dichloroethane	0.1	nd	0.1	yes	99	70	130	yes
1,1,1-Trichloroethane	0.1	nd	0.1	yes	101	70	130	yes
Carbon Tetrachloride	0.1	nd	0.1	yes	100	70	130	yes
Benzene	0.1	nd	0.1	yes	103	70	130	yes
1,2-Dichloropropane	0.1	nd	0.1	yes	100	70	130	yes
Trichloroethene (Trichloroethylene)	0.1	nd	0.1	yes	101	70	130	yes
Bromodichloromethane	0.1	nd	0.1	yes	101	70	130	yes
cis-1,3-Dichloropropene	0.2	nd	0.2	yes	102	70	130	yes
Methyl Isobutyl Ketone (MIBK)	5.0	nd	5.0	yes	101	60	140	yes
trans-1,3-Dichloropropene	0.2	nd	0.2	yes	101	70	130	yes
1,1,2-Trichloroethane	0.2	nd	0.2	yes	102	70	130	yes
Toluene	0.2	nd	0.2	yes	103	70	130	yes
2-Hexanone	5.0	nd	5.0	yes	103	60	140	yes
Dibromochloromethane	0.2	nd	0.2	yes	104	70	130	yes
1,2-Dibromoethane (Ethylene dibromide)	0.2	nd	0.2	yes	103	70	130	yes
Tetrachloroethene (Perchloroethylene)	0.1	nd	0.1	yes	103	70	130	yes
1,1,1,2-Tetrachloroethane	0.1	nd	0.1	yes	102	70	130	yes
Chlorobenzene	0.1	nd	0.1	yes	102	70	130	yes
Ethylbenzene	0.1	nd	0.1	yes	102	70	130	yes
m-Xylene & p-Xylene	0.1	nd	0.1	yes	102	70	130	yes
Bromoform	0.2	nd	0.2	yes	103	70	130	yes
Styrene	0.1	nd	0.1	yes	104	70	130	yes
1,1,2,2-Tetrachloroethane	0.2	nd	0.2	yes	102	70	130	yes
o-Xylene	0.1	nd	0.1	yes	103	70	130	yes
1,3-Dichlorobenzene	0.1	nd	0.1	yes	102	70	130	yes
1,4-Dichlorobenzene	0.1	nd	0.1	yes	101	70	130	yes
1,2-Dichlorobenzene	0.1	nd	0.1	yes	102	70	130	yes
Surrogate Standard Recoveries	(Control Limits)							
Dibromofluoromethane		98%	70-130%	yes	100	70	130	yes
Toluene-d8		104%	70-130%	yes	102	70	130	yes
4-Bromofluorobenzene		94%	70-130%	yes	100	70	130	yes

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256386
Matrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Units: micrograms/liter (ug/L)

Compound	EQL ug/L	Spiked Sample (ID)	Spiked Sample Amount Spiked	Spiked Sample % Recovery	Lower Limit	Upper Limit	Accept
Chloromethane	0.5	MMM02-SS2(M)	10.0	101	60	140	yes
Vinyl Chloride	0.2	MMM02-SS2(M)	10.0	100	60	140	yes
Bromomethane	0.5	MMM02-SS2(M)	10.0	98	60	140	yes
Chloroethane	0.2	MMM02-SS2(M)	10.0	100	60	140	yes
Trichlorofluoromethane	0.2	MMM02-SS2(M)	10.0	105	60	140	yes
Acetone	10.0	MMM02-SS2(M)	50.0	45	60	140	(1)
1,1-Dichloroethene	0.1	MMM02-SS2(M)	5.0	103	70	130	yes
Dichloromethane (Methylene Chloride)	1.0	MMM02-SS2(M)	5.0	97	70	130	yes
trans-1,2-Dichloroethene	0.1	MMM02-SS2(M)	5.0	100	70	130	yes
Methyl-t-Butyl Ether	0.2	MMM02-SS2(M)	5.0	98	70	130	yes
1,1-Dichloroethane	0.1	MMM02-SS2(M)	5.0	100	70	130	yes
Methyl Ethyl Ketone (MEK)	5.0	MMM02-SS2(M)	25.0	64	60	140	yes
cis-1,2-Dichloroethene	0.1	MMM02-SS2(M)	5.0	98	70	130	yes
Chloroform	0.1	MMM02-SS2(M)	5.0	97	70	130	yes
1,2-Dichloroethane	0.1	MMM02-SS2(M)	5.0	95	70	130	yes
1,1,1-Trichloroethane	0.1	MMM02-SS2(M)	5.0	101	70	130	yes
Carbon Tetrachloride	0.1	MMM02-SS2(M)	5.0	102	70	130	yes
Benzene	0.1	MMM02-SS2(M)	2.0	98	70	130	yes
1,2-Dichloropropane	0.1	MMM02-SS2(M)	5.0	98	70	130	yes
Trichloroethene (Trichloroethylene)	0.1	MMM02-SS2(M)	5.0	100	70	130	yes
Bromodichloromethane	0.1	MMM02-SS2(M)	5.0	97	70	130	yes
cis-1,3-Dichloropropene	0.2	MMM02-SS2(M)	5.0	100	70	130	yes
Methyl Isobutyl Ketone (MIBK)	5.0	MMM02-SS2(M)	25.0	99	60	140	yes
trans-1,3-Dichloropropene	0.2	MMM02-SS2(M)	10.0	97	70	130	yes
1,1,2-Trichloroethane	0.2	MMM02-SS2(M)	10.0	99	70	130	yes
Toluene	0.2	MMM02-SS2(M)	2.0	96	70	130	yes
2-Hexanone	5.0	MMM02-SS2(M)	25.0	70	60	140	yes
Dibromochloromethane	0.2	MMM02-SS2(M)	10.0	96	70	130	yes
1,2-Dibromoethane (Ethylene dibromide)	0.2	MMM02-SS2(M)	10.0	99	70	130	yes
Tetrachloroethene (Perchloroethylene)	0.1	MMM02-SS2(M)	5.0	101	70	130	yes
1,1,1,2-Tetrachloroethane	0.1	MMM02-SS2(M)	5.0	98	70	130	yes
Chlorobenzene	0.1	MMM02-SS2(M)	2.0	98	70	130	yes
Ethylbenzene	0.1	MMM02-SS2(M)	2.0	100	70	130	yes
m-Xylene & p-Xylene	0.1	MMM02-SS2(M)	2.0	100	70	130	yes
Bromoform	0.2	MMM02-SS2(M)	10.0	92	70	130	yes
Styrene	0.1	MMM02-SS2(M)	5.0	96	70	130	yes
1,1,2,2-Tetrachloroethane	0.2	MMM02-SS2(M)	10.0	100	70	130	yes
o-Xylene	0.1	MMM02-SS2(M)	2.0	98	70	130	yes
1,3-Dichlorobenzene	0.1	MMM02-SS2(M)	5.0	97	70	130	yes
1,4-Dichlorobenzene	0.1	MMM02-SS2(M)	5.0	96	70	130	yes
1,2-Dichlorobenzene	0.1	MMM02-SS2(M)	5.0	95	70	130	yes
Surrogate Standard Recoveries	(Control Limits)						
Dibromofluoromethane		MMM02-SS2(M)	8.0	98	70	130	yes
Toluene-d8		MMM02-SS2(M)	4.0	100	70	130	yes
4-Bromofluorobenzene		MMM02-SS2(M)	8.0	98	70	130	yes

Client: Marshall Macklin Monaghan Ltd.
Work Order: 2256386
Matrix: Water

VOLATILE ORGANIC COMPOUNDS

Date: 12-Jul-02

Legend: EQL = Estimated Quantitation Limit for undiluted samples
nd = Not Detected Above EQL
Dup. = Duplicate
* = Detected below EQL but passed compound identification criteria

Date of sample receipt: July 3, 2002
Date of sample analysis: July 07 - 08, 2002

Analytical Method:

The water samples were analysed by purge & trap gas chromatography/mass spectrometry using US EPA Method 8260B (modified).

Report Discussion:

Since some target compounds were present at a level above the calibration range of the instrument, some of the samples were run at a dilution factor to avoid exceeding the calibration range and causing excessive contamination of the purge & trap equipment. The quantitation limits for these samples are higher than the EQL's for undiluted samples as indicated in the report. The amounts reported have been corrected for the dilution factors that were used.

(1) The recovery for acetone in the spiked sample MMM02-SS2(M) was below the control limit. However, since this compound was not detected in any of the samples, this has been evaluated as having no significant impact on the reported results.

The results for the analysis of duplicate vials for sample MMM02-4 show significantly different results. Since the differences for these compounds was greater than that due to precision of the method, this appears to be due to differences in the contents of the vials. The third vial provided was used for prescreening leaving no vials available for a confirmation analysis.

Note: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangement.

Job Approved By:

Daniel Kim
Chemist

Client: Marshall Macklin Monaghan Ltd.
Work Order Number: 2256386A
Matrix: Water

Polynuclear Aromatic Hydrocarbons (PAH's)

Date: 11-Jul-02

Units: Micrograms/Liter (µg/L)

Compound	EQL µg/L	MMM02-2	MMM02-4
Naphthalene	0.050	2.74	nd
2-Methylnaphthalene	0.050	0.108	nd
1-Methylnaphthalene	0.050	0.278	nd
Acenaphthylene	0.050	nd	nd
Acenaphthene	0.050	nd	nd
Fluorene	0.050	nd	nd
Phenanthrene	0.050	nd	nd
Anthracene	0.010	0.012	0.015
Fluoranthene	0.010	nd	0.039
Pyrene	0.010	nd	0.028
Benzo(a)anthracene	0.010	nd	nd
Chrysene	0.010	nd	nd
Benzo(b)fluoranthene	0.010	nd	nd
Benzo(k)fluoranthene	0.010	nd	nd
Benzo(a)pyrene	0.010	nd	nd
Indeno(1,2,3-cd)pyrene	0.010	nd	nd
Dibenzo(a,h)anthracene	0.010	nd	nd
Benzo(ghi)perylene	0.010	nd	nd
Surrogate Standard Recoveries (Control Limits)			
Acenaphthene-d10 (19-123%)		63%	67%
Anthracene-d10 (20-134%)		65%	74%
Benzo(a)pyrene-d12 (40-125%)		72%	80%

Client: Marshall Macklin Monaghan Ltd.
Work Order Number: 2256386A
Matrix: Water

Polynuclear Aromatic Hydrocarbons (PAH's)

Units: micrograms/liter (µg/L)

Date: 11-Jul-02

		Method Blank			Spiked Method Blank			
Compound	**EQL µg/L**	**Result**	**Upper Limit**	**Accept**	**% Recovery**	**Lower Limit**	**Upper Limit**	**Accept**
Naphthalene	0.050	nd	0.050	yes	67	31	103	yes
2-Methylnaphthalene	0.050	nd	0.050	yes	70	42	102	yes
1-Methylnaphthalene	0.050	nd	0.050	yes	72	40	102	yes
Acenaphthylene	0.050	nd	0.050	yes	69	25	103	yes
Acenaphthene	0.050	nd	0.050	yes	65	16	120	yes
Fluorene	0.050	nd	0.050	yes	68	17	124	yes
Phenanthrene	0.050	nd	0.050	yes	68	24	110	yes
Anthracene	0.010	nd	0.010	yes	52	10	129	yes
Fluoranthene	0.010	nd	0.010	yes	80	24	134	yes
Pyrene	0.010	nd	0.010	yes	79	24	135	yes
Benzo(a)anthracene	0.010	nd	0.010	yes	70	33	109	yes
Chrysene	0.010	nd	0.010	yes	75	37	112	yes
Benzo(b)fluoranthene	0.010	nd	0.010	yes	86	37	119	yes
Benzo(k)fluoranthene	0.010	nd	0.010	yes	81	42	119	yes
Benzo(a)pyrene	0.010	nd	0.010	yes	45	34	108	yes
Indeno(1,2,3-cd)pyrene	0.010	nd	0.010	yes	84	16	128	yes
Dibenzo(a,h)anthracene	0.010	nd	0.010	yes	83	32	120	yes
Benzo(ghi)perylene	0.010	nd	0.010	yes	76	30	118	yes
Surrogate Standard Recoveries								
Acenaphthene-d10		60%		yes	58	19	123	yes
Anthracene-d10		37%		yes	47	20	134	yes
Benzo(a)pyrene-d12		36%		(1)	44	40	125	yes

Client: Marshall Macklin Monaghan Ltd.
Work Order Number: 2256386A
Matrix: Water

Polynuclear Aromatic Hydrocarbons (PAH'S)

Date: 11-Jul-02

Legend: EQL = Estimated Quantitation Limit
nd = Not detected above EQL

Date received: July 3, 2002
Date extracted: July 9, 2002
Date analysed: July 9, 2002

ANALYTICAL METHOD:

The water samples were prepared by liquid-liquid extraction and analysed by gas chromatography/mass spectrometry in selected ion monitoring mode using U.S. EPA Method 8270C (modified).

REPORT DISCUSSION:

(1) The recovery for the surrogate compound benzo(a)pyrene-d12 was slightly lower than our inhouse tolerance limits. Since the recoveries for benzo(a)pyrene-d12 in the spiked method blank and all of the samples were within our inhouse tolerance limits, this has been evaluated as having no significant impact on the data quality.

Note: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PAS for a period of 30 days following reporting or as per specific contractual arrangement.

Job Approved By:

Floyd Mayede, B.A.Sc.
Supervisor/GC-MS Semivolatiles Group

ANALYTICAL SERVICES

9-Jul-2002

MARSHALL MACKLIN MONAGHAN LIMITED
80 Commerce Valley Drive East
Thornhill, ON
L3T 7N4

Attn: Steve Bridle
Project:

Received: 3-Jul-2002 16:57
PO #: 624-2002-RM

Job: 2256386

Status: Final

Water Samples

Sample Id	PCB's GC/ECD ug/L	DCBP GC/ECD % Recovery
MMM02-2	<0.05	91.0 %
MMM02-4	<0.05	91.0 %
Blank	<0.05	96.0 %
QC Standard (found)	95.0%	100. %
QC Standard (expected)	100. %	100. %
Repeat MMM02-2	<0.05	92.0 %

- DCBP: Decachlorobiphenyl (surrogate standard for PCBs).

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: .....M. R. Riskallah.....

Medhat Riskallah, Ph.D., C.Chem.
Manager, Gas Chromatography Section

ANALYTICAL SERVICES

Client: Marshall Macklin Monaghan Ltd.
Purchase Order No.: 624-2002-RM
Work Order Number: 2256386B
Matrix: Soil

Polynuclear Aromatic Hydrocarbons (PAH's)

Units: Micrograms/gram (µg/g) dry weight

Date: 9-Jul-02

Compound	EQL µg/g	TEST PIT 1	TEST PIT 2
Naphthalene	0.05	0.05	nd
1-Methylnaphthalene	0.05	0.05	nd
2-Methylnaphthalene	0.05	nd	nd
Acenaphthylene	0.05	nd	nd
Acenaphthene	0.05	0.05	nd
Fluorene	0.05	0.06	nd
Phenanthrene	0.05	0.70	nd
Anthracene	0.05	0.21	nd
Fluoranthene	0.05	1.19	nd
Pyrene	0.05	0.92	nd
Benzo(a)anthracene	0.05	0.44	nd
Chrysene	0.05	0.43	nd
Benzo(b)fluoranthene	0.05	0.54	nd
Benzo(k)fluoranthene	0.05	0.19	nd
Benzo(a)pyrene	0.05	0.36	nd
Indeno(1,2,3-cd)pyrene	0.05	0.14	nd
Dibenzo(a,h)anthracene	0.05	nd	nd
Benzo(ghi)perylene	0.05	0.11	nd
Surrogate Standard Recoveries (Control Limits)			
Acenaphthene-d10 (19-121%)		70%	73%
Anthracene-d10 (27-126%)		80%	78%
Benzo(a)pyrene-d12 (44-136%)		82%	79%

ANALYTICAL SERVICES

Client: Marshall Macklin Monaghan Ltd.
Purchase Order No.: 624-2002-RM
Work Order Number: 2256386B
Matrix: Soil

Polynuclear Aromatic Hydrocarbons (PAH's)

Units: Micrograms/gram (µg/g) dry weight

Date: 9-Jul-02

		Method Blank			Spiked Method Blank			
Compound	EQL µg/g	Result	Upper Limit	Accept	% Recovery	Lower Limit	Upper Limit	Accept
Naphthalene	0.05	nd	0.05	yes	56	42	107	yes
2-Methylnaphthalene	0.05	nd	0.05	yes	62	44	114	yes
1-Methylnaphthalene	0.05	nd	0.05	yes	62	46	119	yes
Acenaphthylene	0.05	nd	0.05	yes	63	39	114	yes
Acenaphthene	0.05	nd	0.05	yes	64	34	113	yes
Fluorene	0.05	nd	0.05	yes	65	36	120	yes
Phenanthrene	0.05	nd	0.05	yes	62	40	120	yes
Anthracene	0.05	nd	0.05	yes	64	42	124	yes
Fluoranthene	0.05	nd	0.05	yes	61	47	126	yes
[illegible]	0.05	nd	0.05	yes	61	46	125	yes
[illegible]zo(a)anthracene	0.05	nd	0.05	yes	62	45	142	yes
Chrysene	0.05	nd	0.05	yes	63	46	148	yes
Benzo(b)fluoranthene	0.05	nd	0.05	yes	62	40	135	yes
Benzo(k)fluoranthene	0.05	nd	0.05	yes	61	40	129	yes
Benzo(a)pyrene	0.05	nd	0.05	yes	61	41	128	yes
Indeno(1,2,3-cd)pyrene	0.05	nd	0.05	yes	65	35	132	yes
Dibenzo(a,h)anthracene	0.05	nd	0.05	yes	62	34	137	yes
Benzo(ghi)perylene	0.05	nd	0.05	yes	66	38	130	yes
Surrogate Standard Recoveries								
Acenaphthene-d10		62%			59	19	121	yes
Anthracene-d10		70%			63	27	126	yes
Benzo(a)pyrene-d12		70%			62	44	136	yes

ient: Marshall Macklin Monaghan Ltd. **Polynuclear Aromatic Hydrocarbons (PAH's)**
urchase Order No.: 624-2002-RM **Date:** 9-Jul-02
ork Order Number: 2256386B
atrix: Soil

Legend: EQL = Estimated Quantitation Limit
nd = Not detected above EQL

Date received: July 3, 2002
Date extracted: July 8, 2002
Date analysed: July 8-9, 2002

NALYTICAL METHOD:

he soil samples (10 grams wet weight) were mixed with sodium sulfate and extracted with a 1:1 mixture of ne:dichloromethane. The extracts were cleaned up using alumina column chromatography. Analysis was med by gas chromatography/mass spectrometry using U.S. EPA Method 8270C (modified).

lote: Estimated quantitation limit is the lowest concentration that can be reliably achieved within specified mits of precision and accuracy during routine laboratory operating conditions.

NOTE: All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analysis done. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangement.

JOB APPROVED BY:

Michael Wang, Ph.D.
Chemist

APPENDIX D

DETAILED EVALUATION FORMS

UNDER THE

NATIONAL CLASSIFICATION SYSTEM

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM

Before completing this form, review instructions in text (Section 3.0).

I **CONTAMINANTS CHARACTERISTICS** (Maximum Total Score is 33)
Complete **Sections A, B, C,** and **Special Considerations**
If answer is an estimate, circle the question mark (?) beside your score;
if **not** an estimate circle the checkmark (✓)(see Subsection 3.7.1 in text).

Factors	Scoring Guideline	Site Score	Totals
A **Degree of Hazard** (max. 14)			
• High concern contaminants - high concentration	14		
• High concern contaminants - low concentration	11		
• Medium concern contaminants - high concentration	8		
• Medium concern contaminants - low concentration	5		
• Low concern contaminants	3	14 ?(✓)	14 Section A max. 14
B **Contaminant Quantity** (area or volume of site contamination) (max. 10)			
• >10 ha or 1000 m^3 or drums of liquid	10		
• 2 to 10 ha or 100 to 1000 m^3	6		
• <2 ha or 100 m^3	2	2 ?(✓)	2 Section B max. 10
C **Physical State of Contaminants** (max. 9)			
• Liquid/gas	9		
• Sludge	7		
• Solid	3	3 ?(✓)	3 Section C max. 9
Special Considerations			
Discretionary addition or subtraction to this category score (Contaminant Characteristics) by up to 6 points based on technical judgment of the user. (Special considerations scores must not cause total score for this category to exceed the maximum (33) or be lower than the minimum (0) allowable.)			
DETAILED RATIONALE MUST BE DOCUMENTED	-6 to +6	-2 (✓)	-2 max. 6

			Total "✓"	Total "?"	Total "✓"+"?"
I	**Total Site Score for CONTAMINANT CHARACTERISTICS**	Add: Section A	14		
		Section B	2		
		Section C	3		
		Special Considerations	-2		
		TOTAL	17	0	17 (max. 33)

Site Identification: Oshawa Harbour

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM (Cont'd.)

II EXPOSURE PATHWAYS (Maximum Total Score is 33)
Complete Sections A, B, and C.

A Groundwater (Maximum Score is 11)
Score **Section 1 (Known)** OR **2 (Potential)**, and **Section 3.**
If answer is an estimate, circle the question mark (?) beside your score;
if **not** an estimate circle the checkmark (✓).

Factors	Scoring Guideline	Site Score	Totals
1 Known Contamination of Groundwater at or beyond the Property Boundary (measured contamination of, or known contact with, groundwater (max. 11) • Groundwater significantly exceeds CDWG (by >2x) or known contact of contaminants with groundwater; • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines If impact on groundwater is not known, complete 2	11 6 0	11 ✓	11 Section 1 max. 11
OR 2 Potential for Groundwater Contamination (max. 11)			
a) Engineered subsurface containment (max. 4) • No containment • Partial containment • Full containment	4 2 0	____ ? ✓	
b) Thickness of confining layer over aquifer (max. 1.5) • 3 m or less • 3 to 10 m • >10 m	1.5 1 0	____ ? ✓	
c) Hydraulic conductivity of the confining layer (max. 1.5) • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	1.5 1 0.5	____ ? ✓	
d) Annual rainfall (max. 1) • >1,000 mm • 600 mm • 400 mm • 200 mm	1 0.6 0.4 0.2	____ ? ✓	
e) Hydraulic conductivity of aquifer(s) of concern (max. 3) • $>10^{-2}$ cm/sec • 10^{-2} to 10^{-4} cm/sec • $<10^{-4}$ cm/sec	3 1.5 0.5	____ ? ✓	Section 2 max. 11

3	**Special Considerations** Discretionary addition or subtraction to this sub-category score (Groundwater Pathway) by up to 4 points based on technical judgment of the user. (Special considerations scores must not cause total score for this category to exceed the maximum (11) or be lower than the minimum (0) allowable.) DETAILED RATIONALE MUST BE DOCUMENTED	-4 to +4	___	✓	___ Section 3 max. 4

				Total "✓"	Total "?"	Total "✓"+"?"
A	**Groundwater Total**	Add:	Section 1 or 2	11	___	11
			Section 3	0	___	___
			TOTAL	11	0	11 max. 11

41

Site Identification: Oshawa Harbour

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM (Cont'd.)

II EXPOSURE PATHWAYS (Cont'd.)

B Surface Water (Maximum Score is 11)

Score **Section 1 (Known)** OR **2 (Potential)**, and **Section 3.**

Factors	Scoring Guideline	Site Score	Totals
1 Observed or Measured Contamination of Water/Effluent Discharged from Site (max. 11)			
• Known or strongly suspected to exceed CWQG by >2x	11		
• Known or strongly suspected to be between 1 and 2x CWQG	6		
• Meets Canadian Water Quality Guidelines	0	— ✓	Section 1 max. 11
If impact on surface water is not known, complete 2			
OR 2 Potential for Surface Water Contamination (max. 11)			
a) Surface containment (max. 5)			
• No containment	5		
• Partial containment	3		
• Full containment	0.5	5 ?(✓)	
b) Distance to perennial surface water (max. 3)			
• 0 to <100 m	3		
• 100 - 300 m	2		
• >300 m	0.5	3 ?(✓)	
c) Topography (max. 1.5)			
• Contaminants above ground level and slope is steep	1.5		
• Contaminants at or below ground level and slope is steep	1.2		
• Contaminants above ground level and slope is flat	0.8		
• Contaminants at or below ground level and slope is flat	0	0.8 ?(✓)	
d) Run-off potential (see nomograph at end of Appendix D) (max. 1)			
• >1000 mm rainfall and low permeability surface material	1		
• 500-1000 mm rainfall and moderately permeable surface material	0.6		
• <500 mm rainfall and highly permeable surface material	0.2	0.6 ?(✓)	
e) Flood potential (max. 0.5)			
• 1 in 2 years	0.5		
• 1 in 10 years	0.3		
• 1 in 50 years	0.1	0.3 (?)✓	9.7 Section 2 max. 11

3	**Special Considerations** Discretionary addition or subtraction to this sub-category score (Surface Water Pathway) by up to 4 points based on the technical judgment of the user. (Special considerations scores must not cause the total score for this sub-category to exceed the maximum (11) or be lower than the minimum (0) allowable.) DETAILED RATIONALE MUST BE DOCUMENTED	-4 to +4	0 ✓		Section 3 max. 4

				Total "✓"	Total "?"	Total "✓"+"?"
B	**Surface Water Total**	Add:	Section 1 or 2	9.4	0.3	9.7
			Section 3	0		
			TOTAL	9.4	0.3	9.7 max. 11

II EXPOSURE PATHWAYS (Cont'd.)

C Direct Contact (Maximum Score is 11)

Score **Section 1 (Known)** OR **2 (Potential)**, and **Section 3**

Factors	Scoring Guideline	Site Score	Totals
1 Known Contamination of Media Off-site (max. 11)			
• Known contamination of media (soil, sediment, air) off-site due to direct contact with contaminated soil, dust, air, etc. (vector transported should also be considered)	11		
• Strongly suspected contamination of media (soil, sediment, air) off-site	6		
• No contamination of media off-site	0	— ✓	Section 1 max. 11
If impact due to direct contact is not known, complete **2**			
OR 2 Potential for Direct Human and/or Animal Contact (max. 11)			
a) Airborne Emissions (gases, vapours, contaminated dust, etc.) (max. 5)			
• Known or suspected airborne emissions impacting on neighbouring properties (see User's Guide)	5		
• Airborne emissions generally restricted to site	3		
• No airborne emissions	0	0 ? ✓	
b) Accessibility of Site (Ability to Contact Materials) (max. 4)			
• Limited barriers to prevent site access; contaminants not covered	4		
• Moderate accessibility or no intervening barriers; contaminants are covered	3		
• Controlled access or remote location and contaminants are covered	0	4 ? ✓	
c) Hazardous soil gas migration from the site (max. 2)			
• Contaminants are putrescible and soil permeability is high	2		
• Site contaminants are putrescible but soil permeability is low, and/or groundwater is <2 m from surface	1		
• No putrescible contaminants at the site	0	2 ? ✓	6 Section 2 max. 11
3 Special Considerations			
Discretionary addition or subtraction to this sub-category score (Direct Contact Pathway) by up to 4 points based on the technical judgment of the user. (Special consideration scores must not cause the total score for this sub-category to exceed the maximum (11) or be lower than the minimum (0) allowable.)			
DETAILED RATIONALE MUST BE DOCUMENTED	-4 to +4	2 ✓	2 Section 3 max. 4

				Total "✓"	Total "?"	Total "✓"+"?"
C	**Direct Contact Total**	Add:	Section 1 or 2	6		6
			Section 3	2		2
			TOTAL	8		8 (max. 11)

II	**Total Site Score for EXPOSURE PATHWAYS**	Add:	**A Groundwater**	11		11
			B Surface Water	9.4	0.3	9.7
			C Direct Contact	8		8
			TOTAL	28.4		28.7 (max. 33)

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM (Cont'd.)

III **RECEPTORS** (Maximum Total Score is 34)
Complete Sections A and B.

A **Human and Animal Uses** (Maximum score is 18)
Score **Section 1 (Known)** OR **2 (Potential)**, and **Section 3.**
If answer is an estimate, circle the question mark (?) beside your score; if **not** an estimate circle the checkmark (✓).

Factors	Scoring Guideline	Site Score	Totals
1 **Known Impact on Humans or Animals** (max. 18) Known adverse impact on humans or domestic animals as a result of the contaminated site (see User's Guide) • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals If adverse effect on humans is not known, complete 2	18 15	— ✓	Section 1 max. 18 ↓ Class 1
OR 2 **Potential for Impact on Humans or Animals** (max. 18)			
a) Drinking Water Supply (max. 9) (groundwater or surface water; private, commercial or municipal supply) Complete **Section i) (Known) OR ii) (Potential)**			
i) Known impact on drinking water supply (max. 9) (see User's Guide) • Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply (to levels exceeding CDWG) • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated If impact on drinking water is not known, complete **ii)**	9 7 0	— ✓	
ii) Potential for impact on drinking water supply (max. 9)			
■ Proximity to drinking water supply (max. 6) • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	6 5 4 3	3 (?)✓	
■ "Availability" of alternate drinking water supply (max. 3) • Alternate drinking water supply is not available • Alternate drinking water supply difficult to obtain • Alternate drinking water supply available	3 2 0.5	0.5 ?✓	

Factors	Scoring Guideline	Site Score	Totals

b) Other Water Resources (max. 4)
(groundwater or surface water)

Complete **i) (Known) OR ii) (Potential)**

i) Known impact on water resources (max. 4) (see User's Guide)
Water resources (used for recreational purposes, commercial food preparation, livestock watering, irrigation and other food chain uses) is known to be adversely affected as a result of site contamination

	Scoring Guideline	Site Score
• Water resource is known to be contaminated above CWQG	4	
• Water resource is strongly suspected to be contaminated above CWQG	3	
• Water resource is known not to be contaminated	0	— ✓

If impact on water resource is not known, complete **ii)**

ii) Potential for impact on water resources (max. 4)

■ Proximity to water resources used for activities listed above (max. 2)

	Scoring Guideline	Site Score
• 0 to <100 m	2	
• 100 to <300 m	1.5	
• 300 m to <1 km	1	
• 1 to 5 km	0.5	2 ?✓

■ Use of water resources (max. 2)
If multiple uses, give highest score automatically
(use following table)

Water Use	Frequency of Use: Frequent	Occasional	Site Score
Recreational (swimming, fishing, etc.)	2	1	
Commercial food preparation	1.5	0.8	
Livestock watering	1	0.5	
Irrigation	1	0.5	
Other domestic or food chain uses	0.5	0.3	2 ?✓
Not currently used but likely future use	0.5	0.2	

Site Identification: Oshawa Harbour **DETAILED EVALUATION FORM** (Cont'd.)

III RECEPTORS (Cont'd.)

A Human and Animal Use (Cont'd.)

Factors	Scoring Guideline	Site Score	Totals
c) Direct Human Exposure (max. 5)			
Complete i) (Known) OR ii) (Potential)			
i) Known contamination of land used by humans (max. 5) (see User's Guide)			
• Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values.	5		
• Known contamination of land used for commercial or industrial purposes above C/I EQC values.	3.5	5 ✓	
• Land is known not be contaminated	0		
If impact on used land is not known, complete ii)			
ii) Potential human exposure through land use (give highest score to worst case scenario) (max. 5)			
■ Use of land at and surrounding site. Determine use(s) of land at and surrounding site and assign score using following table:			

Distance from Site

Land Use	0-<300 m	300 m-<1 km	1 km-5 km
Residential	5	4.5	3
Agricultural	5	4	2.5
Parkland/School	4	3	1.5
Commercial/Industrial	3	1	0.5

___ ? ✓

12.5 — Section 2 max. 18

3 Special Considerations

Discretionary addition or subtraction to this sub-category (Impact on Human and Animal Receptors) by up to 5 points based on the technical judgment of the user. (Special considerations score must not cause the total score for this sub-category to exceed the maximum (18) or be lower than the minimum (0) allowable.)

DETAILED RATIONALE MUST BE DOCUMENTED — -5 to +5 ___ ✓

0 — Section 3 max. 5

				Total "✓"	Total "?"	Total "✓"+"?"
A	**Total Human and Animal Receptors**	Add:	Section 1 or 2	9.5	3	12.5
			Section 3			
			TOTAL	9.5	3	12.5 max. 18

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM (Cont'd.)

III RECEPTORS (Cont'd.)

B Environmental Receptors (Maximum Score is 16)
Score **Section 1 (Known)** OR **2 (Potential)**, and **Section 3**

Factors		Scoring Guideline	Site Score	Totals
1	**Known Adverse Impact on the Environment as a Result of the Contaminated Site** (max. 16) • Known adverse impact on sensitive environment • Evidence of stress on aquatic species, or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment If impact on the environment is not known, complete 2.	16 14 12	___ ✓	___ Section 1 max. 16
OR 2	**Potential for Impact on Sensitive Environments** (max. 16)			
	a) Distance from the site to the nearest sensitive environment (max. 10) (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	10 6 2 0.5	10 ?✓	
	b) Groundwater (max. 6) Distance to an important or susceptible groundwater resource (e.g. recharge area) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	6 4 2 1	1 ?✓	___ Section 2 max. 16
3	**Special Considerations** Discretionary addition or subtraction to this sub-category (Environmental Receptors) by up to 5 points based on the technical judgment of the user. (Special considerations score must not cause total score for this sub-category to exceed the maximum (16) or be lower than the minimum (0) allowable.) DETAILED RATIONALE MUST BE DOCUMENTED	-5 to +5	___ ✓	___ Section 3 max. 5

				Total "✓"	Total "?"	Total "✓"+"?"
B	**Total Environmental Receptors**	Add:	Section 1 or 2	10	1	11
			Section 3			
			TOTAL	10	1	11
						max. 16

III	**Total Site Score for RECEPTORS**	Add:	**A**	**Human and Animal Use**	9.5	3	12.5
			B	**Environmental Receptors**	11	1	11
				TOTAL	19.5	4	23.5
							max. 34

Site Identification: Oshawa Harbour

DETAILED EVALUATION FORM (Cont'd.)

FINAL SCORE SHEET AND SITE CATEGORIES

Factor Categories	Category Score (CS) ("✓" + "?")	Estimated Score (ES) ("?" only)	Total Category Score (CS)	Total Estimated Score (ES)
I CONTAMINANT CHARACTERISTICS (33)	17		Total → 17	±
II EXPOSURE PATHWAYS (33)				
A Groundwater (11)	11			
B Surface Water (11)	9.7	0.3		
C Direct Contact (11)	8			
Total	28.7	0.3	Total → 28.7	± 0.3
III RECEPTORS (34)				
A Human and Animal (18)	12.5	3		
B Environment (16)	11	1		
Total	23.5	4	Total → 23.5	± 4
			69.2	± 4.3

TOTAL SCORE FOR THE SITE (TS) (Sum of scores marked "✓" and "?", rounded to nearest whole number)

ESTIMATED SCORE FOR SITE (ES) (Sum of scores marked "?", i.e. score estimated or unkown)

SITE SCORE	CLASS	RISK POTENTIAL	ACTION REQUIRED
70 - 100	Class 1	High	Yes
50 - 69	Class 2	Medium	Likely
38 - 49	Class 3	Medium Low	May Be
≤37	Class N	Low	Not Likely

CLASSIFICATION (1, 2, 3, or N)
If ES ≥15, then site is categorized as I (insufficient information to classify site)

2

APPENDIX E

FLOWPATH MODELLING PARAMETERS

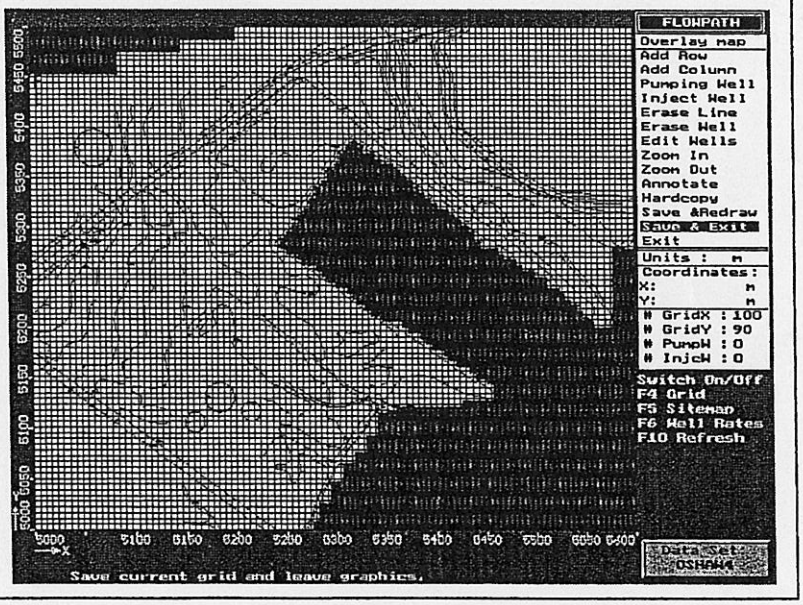
APPENDIX E

GROUNDWATER MODELLING USING FLOWPATH

A groundwater model was developed using FLOWPATH to achieve a better understanding of the present groundwater flow conditions, to explore some of the leachate management alternatives, and to evaluate the potential impact of the proposed infilling of Basin 3 on the groundwater flow. FLOWPATH is a numerical model that allows two-dimensional groundwater flow simulation. This model was selected because it provides enough tools for an initial assessment of the hydrogeological conditions at the site.

The site area that was modelled was 0.3 sq. km in size. The western edge of the model intercepts Simcoe Street and the eastern edge is positioned to include Montgomery Creek. The northern limit is set north of Harbour Road and the southern limit is determined by the Oshawa Harbour shoreline. A grid was developed across the model area of 100 columns by 90 rows (cells size of 6 by 6 meters) for the purposes of inputting the data.

Groundwater Model Grid



Specified head boundaries were defined based on anticipated groundwater levels and the water level in the Harbour. Montgomery Creek was simulated defining river/lake nodes and assigning values for water level (between 75.3 and 75.27 m.a.s.l), bottom elevation (72.3 m.a.s.l.) and leakage factor (0.3 day^{-1})

The model simulates a one-layer unconfined aquifer with approximately 4.5 m of saturated thickness. Hydraulic properties were estimated based on the soil/fill type in boreholes. A horizontal hydraulic conductivity of 5 m/d was used for all the active cells. A recharge value of 100 mm/year was also used across the modelling area.

The model was run simulating steady-state conditions. It was calibrated using a trial and error procedure to adjust the hydraulic parameters and recharge, in order to match the known groundwater levels at the locations of the six monitoring wells installed during the subsurface investigation.

Various scenerios were run using the model, including the:

1. existing conditions,
2. the conditions after infilling Basin 3,
3. influence of one pumping well located in the Central Area of the site,
4. the influence of three pumping wells located in the Central Area of the site,
5. the influence of installation of an extraction trench along Basin 3 and Montgomery Creek.

A discussion of findings is presented in Sections 4 and 8 of the report.

APPENDIX F

BIOCHLOR MODELLING DATA

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel '97

City of Oshawa
Marina
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or 0.02 → 2. Calculate by filling in gray cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes (◉) Ethanes (○)

1. ADVECTION

Seepage Velocity*	Vs	21.7	(ft/yr)
or			
Hydraulic Conductivity	K	1.0E-04	(cm/sec)
Hydraulic Gradient	i	0.042	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	40	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)	
FractionOrganicCarbon, foc	1.0E-3	(-)	
Partition Coefficient	Koc		
PCE	426	(L/kg)	4.62 (-)
TCE	130	(L/kg)	2.11 (-)
DCE	125	(L/kg)	2.06 (-)
VC	30	(L/kg)	1.25 (-)
ETH	302	(L/kg)	3.57 (-)
Common R (used in model)* =			2.11

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.578	1.20	0.79
TCE → DCE	0.770	0.90	0.74
DCE → VC	0.210	3.30	0.64
VC → ETH	0.267	2.60	0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	20	(yr)
Modeled Area Width*	400	(ft)
Modeled Area Length*	400	(ft)
Zone 1 Length*	400	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Continuous / Single Planar

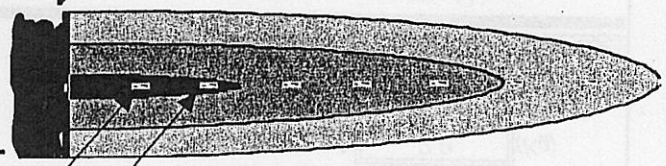
Source Options

Source Thickness in Sat. Zone* 16 (ft)

Width* (ft) Y1: 200

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0
TCE	.267	0
DCE	.351	0
VC	.108	0
ETH		0

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.0	
TCE Conc. (mg/L)	.267	.0
DCE Conc. (mg/L)	.351	.008
VC Conc. (mg/L)	0.1	.027
ETH Conc. (mg/L)		
Distance from Source (ft)	0	75
Date Data Collected	2002	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

Start Here → ○ PCE ◉ TCE ○ DCE ○ VC ○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

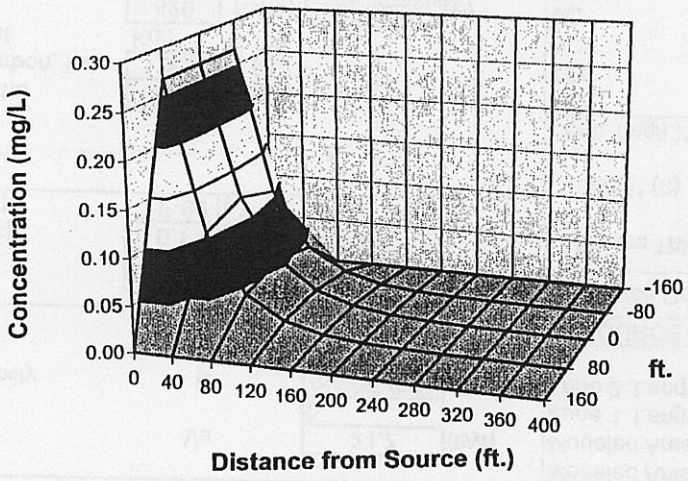
Transverse Distance (ft) ↓ / Distance from Source (ft)	0	40	80	120	160	200	240	280	320	360	400
160	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
80	0.267	0.105	0.043	0.018	0.008	0.004	0.002	0.001	0.000	0.000	0.000
0	0.267	0.121	0.055	0.025	0.011	0.005	0.002	0.001	0.000	0.000	0.000
-80	0.267	0.105	0.043	0.018	0.008	0.004	0.002	0.001	0.000	0.000	0.000
-160	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
MASS RATE (mg/day)	2.9E+2	1.4E+2	6.1E+1	2.7E+1	1.2E+1	5.5E+0	2.5E+0	1.1E+0	4.9E-1	2.2E-1	9.2E-2

Show No Degradation

Show Biotransformation

Displayed Compound: TCE

Time: 20 yr Target Level: 0.005 mg/L Displayed Model: Biotransformation



Plot All Data | Plot Data > Target

Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	2.6	(Kg)
- Plume Mass If Biotransformation/Production	0.6	(Kg)
Mass Removed	2.0	(Kg)

If "Can't Calc.", make model area longer

% Biotransformed = +76.4%

% Change in Mass Rate = 100.0 % (source to edge)

See MGal

Current Volume of Ground Water in Plume	3.76	acre-ft
Flow Rate of Water Through Source Area	0.319	acre-ft/yr

Compare to Pump and Treat

Pumping Rate		(gpm)
# Pore Volumes Removed Per Yr.	0.00	
# Pore Volumes to Clean-Up		
Clean-Up Time		(yr)

Mass HELP | To Centerline | Return to Input

Start Here → ○ PCE ○ TCE ◉ DCE ○ VC ○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

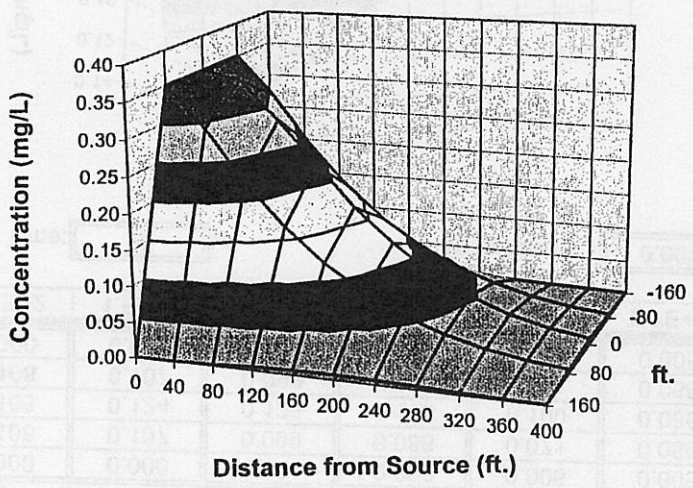
Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	40	80	120	160	200	240	280	320	360	400
160	0.000	0.000	0.003	0.006	0.008	0.008	0.007	0.006	0.004	0.003	0.002
80	0.351	0.293	0.223	0.165	0.119	0.084	0.056	0.036	0.022	0.013	0.007
0	0.351	0.338	0.284	0.223	0.167	0.119	0.082	0.053	0.033	0.019	0.010
-80	0.351	0.293	0.223	0.165	0.119	0.084	0.056	0.036	0.022	0.013	0.007
-160	0.000	0.000	0.003	0.006	0.008	0.008	0.007	0.006	0.004	0.003	0.002
MASS RATE (mg/day)	3.8E+2	4.0E+2	3.2E+2	2.4E+2	1.8E+2	1.3E+2	9.0E+1	5.9E+1	3.7E+1	2.2E+1	1.2E+1

Show No Degradation

Show Biotransformation

Displayed Compound: DCE

Time: 20 yr Target Level: 0.070 mg/L Displayed Model: Biotransformation



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation	3.4	(Kg)
- Plume Mass If Biotransformation/Production	2.4	(Kg)
Mass Removed	0.9	(Kg)

If "Can't Calc." make model area longer

% Biotransformed = +27.7%

% Change in Mass Rate = 96.9 % (source to edge)

See MGal

Current Volume of Ground Water in Plume	Can't Calc.	acre-ft
Flow Rate of Water Through Source Area	0.319	acre-ft/yr

Compare to Pump and Treat

Pumping Rate		(gpm)
# Pore Volumes Removed Per Yr.		
# Pore Volumes to Clean-Up		
Clean-Up Time		(yr)

Plot All Data Plot Data > Target

Mass HELP To Centerline Return to Input

Start Here → ○ PCE ○ TCE ○ DCE ◉ VC ○ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	40	80	120	160	200	240	280	320	360	400
160	0.000	0.000	0.001	0.003	0.005	0.005	0.005	0.004	0.003	0.002	0.001
80	0.108	0.107	0.099	0.086	0.071	0.056	0.041	0.028	0.018	0.011	0.006
0	0.108	0.124	0.125	0.116	0.100	0.080	0.059	0.041	0.027	0.016	0.009
-80	0.108	0.107	0.099	0.086	0.071	0.056	0.041	0.028	0.018	0.011	0.006
-160	0.000	0.000	0.001	0.003	0.005	0.005	0.005	0.004	0.003	0.002	0.001
MASS RATE (mg/day)	1.2E+2	1.5E+2	1.4E+2	1.3E+2	1.1E+2	8.7E+1	6.5E+1	4.6E+1	3.0E+1	1.8E+1	1.0E+1

Show No Degradation

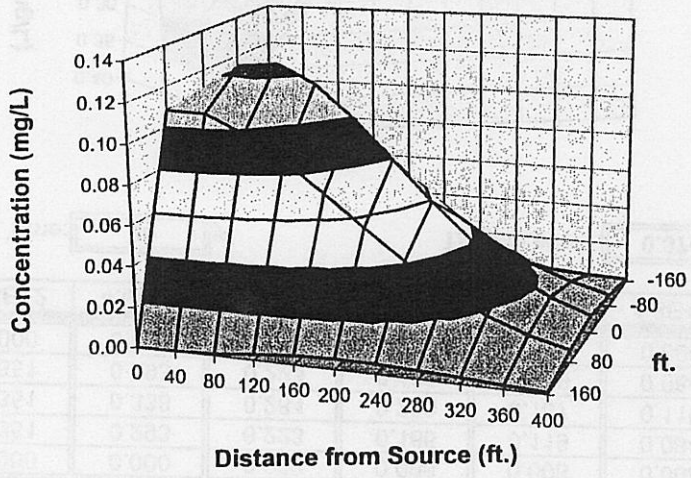
Show Biotransformation

Displayed Compound: VC

Time: 20 yr

Target Level: 0.002 mg/L

Displayed Model: Biotransformation



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation: 1.0 (Kg)

- Plume Mass If Biotransformation/Production: 1.2 (Kg)

Mass Removed: -0.2 (Kg)

If "Can't Calc." make model area longer

% Biotransformed = -16.2 %

% Change in Mass Rate = 91.1 % (source to edge)

See MGal

Current Volume of Ground Water in Plume: Can't Calc. acre-ft

Flow Rate of Water Through Source Area: 0.319 acre-ft/yr

Compare to Pump and Treat

Pumping Rate: (gpm)

Pore Volumes Removed Per Yr.:

Pore Volumes to Clean-Up:

Clean-Up Time: (yr)

Plot All Data | Plot Data > Target

Mass HELP | To Centerline | Return to Input

Start Here → ○ PCE ○ TCE ○ DCE ○ VC ◉ ETH

DISSOLVED SOLVENT CONCENTRATIONS IN PLUME

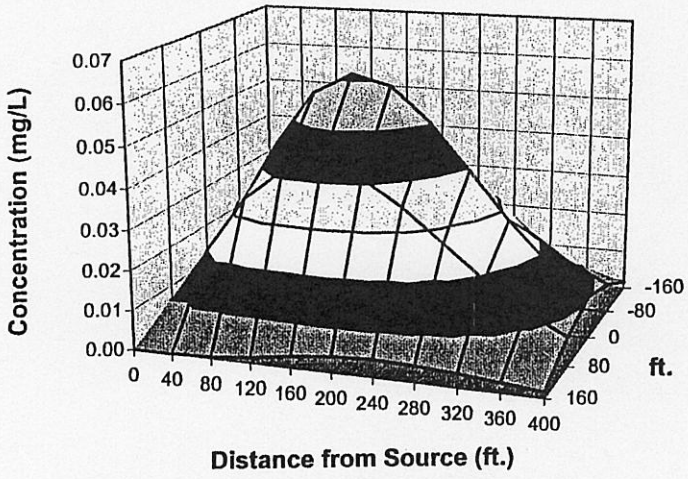
Transverse Distance (ft) ↓	Distance from Source (ft) 0	40	80	120	160	200	240	280	320	360	400
160	0.000	0.000	0.000	0.001	0.003	0.004	0.004	0.004	0.003	0.003	0.002
80	0.000	0.020	0.034	0.042	0.044	0.041	0.035	0.027	0.019	0.012	0.007
0	0.000	0.023	0.043	0.056	0.061	0.059	0.051	0.039	0.028	0.018	0.011
-80	0.000	0.020	0.034	0.042	0.044	0.041	0.035	0.027	0.019	0.012	0.007
-160	0.000	0.000	0.000	0.001	0.003	0.004	0.004	0.004	0.003	0.003	0.002
MASS RATE (mg/day)	6.4E-6	2.8E+1	4.8E+1	6.1E+1	6.7E+1	6.4E+1	5.6E+1	4.4E+1	3.2E+1	2.1E+1	1.2E+1

Show No Degradation

Show Biotransformation

Displayed Compound: ETH

Time: 20 yr Target Level: mg/L Displayed Model: Biotransformation



Plume Mass (Order-of-Magnitude Accuracy)

See Gallons

Plume Mass If No Degradation: 0.0 (Kg)

- Plume Mass If Biotransformation/Production: 0.6 (Kg)

Mass Removed: -0.6 (Kg)

If "Can't Calc.", make model area longer

% Biotransformed =

% Change in Mass Rate = ########## (source to edge)

See MGal

Current Volume of Ground Water in Plume: Can't Calc. acre-ft

Flow Rate of Water Through Source Area: 0.319 acre-ft/yr

Compare to Pump and Treat

Pumping Rate: (gpm)

Pore Volumes Removed Per Yr.:

Pore Volumes to Clean-Up:

Clean-Up Time: (yr)

Plot All Data | Plot Data > Target | Mass HELP | To Centerline | Return to Input

APPENDIX G

ASSUMPTIONS USED TO DEVELOP COST ESTIMATES

Assumptions Made In Preparing the Cost Estimates

Excavation volume to completely remove dumpsite: ..... 38,200 m^3
Volume of soil requiring disposal: ..... 26,200 m^3
Volume to be contaminated sediment in the basin: ..... 7,500 m^3
Volume of cut and fill required to grade site: ..... 13,000 m^3
Volume of clay required to cap site: .....6,750 to 9,750 m^3
Volume of topsoil required to cap site: .....1,688 to 2,438 m^3
Volume of Basin 3: ..... 13000 m^2 by 2 metres deep
Area of dumpsite: ..... 11,250 m^3
Length of contact face along Montgomery Creek and Basin 3: .....300 metres
Excavation cost: ..... $4 to $7 per m^3
Soil Disposal: ..... $50 to $75 per tonne ($90 to $135 per m^3)
Imported backfill from quarry or local source: ..... $20 to $30 per m^3
Import dredged material to use as backfill: .....$3 to $5 per tonne
Import clay from remote source: ..... $40 to $60 per m^3
Import clay from McAsphalt or similar local source: .....$6 to $10 per tonne
Import topsoil: ..... $2 to $3 per m^3
Cost for dredging: ..... $25 to $50 per m^3
General onsite grading and earthworks cost: ..... $2 to $3 per m^3
Restoration/replacement of road: ..... $30 per metre
General site clearing and grubbing: .....$5000 to $10000
Hydroseed: ..... $0.05 to 0.1 per m^2
Supply and installation of collection trench: .....$300 to $500 per metre
Supply and installation of low permeability barrier: ..... $100 to $200 per m^2
Dewater site during excavation:.....$1,500 per day
Supervision during remediation:.....$750 per day
Pumping System to sewer (assumes no treatment):.....$60,000 to $100,000
General engineering support during remediation: .....$50,000 to 75,000
Contingency:.....10% of budget
Length of time to dewater: ..... 20 to 30 days